EFFECTS OF FIRE AND GRAZING ON MALPAI BORDERLANDS HERPETOFAUNA: A MULTIFACETED RESEARCH PROGRAM

Effects of Fire and Grazing on Malpai Borderlands Herpetofauna: A Multifaceted Research Program

FINAL REPORT
(FY2002-2007)

Submitted By:

Matt Goode, Principal Investigator
School of Natural Resources
University of Arizona

Submitted To:

Jerry Gottfried
Rocky Mountain Research Station
United States Forest Service

January 31, 2008

Introduction

The purpose of this agreement was to conduct long-term research on the effects of fire and grazing on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Mexico. Beginning in 2002, we have investigated single species, population, and community level effects of fire and grazing on a variety of herpetofauna in the Peloncillo and Animas Mountains, the Sierra San Luis in Mexico, and in grasslands at McKinney Flats on the Diamond A Ranch in New Mexico.

The original agreement (USFS/02-JV-11221615-279) ended in September 2007, at which time we established a new agreement (USFS/07-JV-11221656-374) to continue with the research program. The final report for the initial agreement consists of detailed work plans and interim reports for each annual phase of the project. It is important to understand that our research program has been, and will continue to be, adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency and the Malpai Borderlands Group, funding availability, weather conditions, changes in fire and grazing plans, and the realities of field work in a highly variable environment. Due to this adaptive approach, and to better document changes made along the way, we felt it would be more informative to bundle annual reports rather than produce a stand-alone final report with cumbersome explanations of when and why changes were made. These details can be found in annual work plans and interim reports.

In addition, we have included, in a separate document, the 2008 annual work plan, which outlines what we plan to accomplish during the upcoming field season, and includes our requested budget. We have experienced budget cuts nearly every year since the beginning of the initial agreement, and we have been asked to consider further cuts in FY08. Therefore, we have prioritized research projects and reduced our funding request accordingly.

Effects of Fire on Herpetofauna in the Malpai Borderlands Region: A Multifaceted Research Program

DETAILED WORK PLAN - 2003
(USFS Agreement Number: 02-JV-11221615-279)

Submitted By:

Matt Goode, Principal Investigator
Desert Southwest Cooperative Ecosystem Studies Unit
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

May 26, 2003

Introduction

The purpose of this agreement is to develop a long-term research program designed to investigate the effects of fire on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Sonora and Chihuahua. We plan to conduct three separate studies, lasting three years each, phased in over the next five years, for a total of six one-year phases (Phase I [2002] is nearly completed). We will investigate single species, population, and community level effects of fire on a variety of herpetofauna. In addition, we will also study how fire may affect ecological processes such as predator-prey dynamics, and trophic relationships. The title and brief description of each project follows.

1) Effects of Fire on New Mexican Ridge-nosed Rattlesnakes in the Peloncillo Mountains

In this project, we will examine the effects of fire on various aspects of New Mexican ridge-nosed rattlesnake (*Crotalus willardi obscurus*) ecology. These rattlesnakes are threatened under the Endangered Species Act, so the need to obtain information about the species that can be used to develop effective management strategies is a high priority. Furthermore, the species has been at the center of a lively debate over how to restore fire to the Peloncillos without harming the snake or its habitat. Much of this debate has been based on a paucity of ecological data. Therefore, our goal is to conduct an intensive three-year study of *C. w. obscurus* in order to learn more about their ecological requirements, and how they respond to changes associated with fire. The fire management plan for the Peloncillo Mountains is nearing finalization, with several prescribed burns scheduled over the next three years. We plan to take advantage of these prescribed burns to help elucidate the effects of fire on this rare snake.

2) Effects of Fire and Grazing on Grassland Herpetofauna in the Animas Valley

We plan to take advantage of ongoing, landscape-scale research being conducted by Charles Curtin (Arid Lands Project) and associates at McKinney Flats on the Gray Ranch. We will examine the effects of fire on a variety of herpetofauna in a manipulative context. We will focus on hog-nosed snakes (*Heterodon nasicus*) and prairie rattlesnakes (*Crotalus viridis*), two common grassland species. We will use radiotelemetry to study movement patterns and habitat use as it relates to different treatment types (fire, grazing, fire and grazing in combination, and neither fire or grazing). We will tap into existing datasets on species diversity and relative abundance of herpetofauna and small mammals to investigate the manner in which snakes are affected by changes in their prey base. We will determine diet of snakes based on fecal analyses and feeding observations. Because toads are known be a primary food source of hog-nosed snakes, we will also monitor toad breeding aggregations to see if we can document hog-nosed snake predation at these sites. Investigating the effects of fire and grazing on ecological processes such as predator-prey interactions is widely recognized as important, but is seldom addressed

3) Effects of Fire on Herpetofauna in Replicated Watersheds at Cascabel Ranch

In this project, we plan to take advantage of a long-term study at Cascabel Ranch, on the eastern edge of the Peloncillo Mountains, where Jerry Gottfried (US Forest Service) and associates are conducting research on the effects of fire on hydrological regimes. At Cascabel Ranch, several watersheds have been instrumented and will be calibrated when sufficient monsoon rains occur. We plan to use a before-after-control-impact (BACI) study design with paired sampling to analyze data obtained from

herpetofauna surveys of these watersheds. We will obtain baseline data on species composition and relative diversity of amphibians and reptiles in several watersheds prior to burning. These data will be compared to post-burn surveys of both burned and unburned watersheds in order to assess the effects, if any, that fire has on resident herpetofauna. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna.

Phase I

Phase I of this research program is nearing completion. Our objectives in the initial phase were to (1) conduct snake surveys and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna.

From September to November 2002, we surveyed for montane snakes in burned and unburned areas in the Sierra San Luis. Concurrently, we identified sites for long-term radiotelemetry studies in both burned and unburned areas. Unfortunately we were unable to obtain Mexican permits authorizing us to initiate radiotelemetry. Matt Goode will no longer be the principal investigator on the work being conducted in the Sierra San Luis. Instead, Gary Belovsky at the University of Notre Dame will be the principal investigator. According to Kirk Setser, graduate student in charge of fieldwork on the project, Mexican permits should be obtained prior to summer 2003, at which time radiotelemetry based work will proceed. We were also unable to characterize snake habitat. We felt that data from snake encounters would be biased because we chose to look for snakes where we thought we would have the best chance of finding them. Therefore, as part of the Sierra San Luis study, data from snakes monitored with radio transmitters will be used for habitat quantification.

During our surveys in the Sierra San Luis, we inspected three burned and three unburned sites on the western slope of the range. We also briefly investigated three unburned areas on the eastern slope. We found 24 individual snakes, comprising seven species. Of the three focal species, we found no *Crotalus lepidus*, eight *C. willardi*, and two *Lampropeltis pyromelana*. We found *C. willardi* at both burned and unburned sites. *Lampropeltis pyromelana* were only encountered at an unburned area.

We spent considerable time meeting with key players involved in the Peloncillo Mountains Fire Management Plan, including members of the Malpai Borderlands Group, Animas Foundation, The Nature Conservancy , US Forest Service, Arizona Game and Fish Department, New Mexico Department of Game and Fish, and US Fish and Wildlife Service.
Specifically, we attended the Malpai Borderlands Group Board of Directors Meeting on October 17th and participated in meetings with the Snake Advisory Group panel in late October. During these trips, as well as during another trip with Peter Warren of the Nature Conservancy in early October, we examined the experimental plots at McKinney Flats and Cascabel Ranch. In April 2003, we attended the Technical Advisory Visit organized by Carl Edminster in Douglas, Arizona and at the Malpai Borderlands Group offices at the Glenn Ranch east of Douglas. At this meeting, we had the opportunity to address meeting participants about our research program, and to discuss project design and logistics with numerous key collaborators. We received excellent input those involved, made important contacts with other investigators, and obtained information about timing of ongoing projects that was necessary for us to develop our plans further.

Phase II

In this phase, we will begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch, initiate radiotelemetry studies of snakes at McKinney Flats, and conduct limited surveys for ridge-nosed rattlesnakes in previously burned areas within the Peloncillo Mountains, including the recently burned prescribed fire, the Baker Fire. It is imperative to begin fieldwork on all three projects now in order to obtain as much baseline data as possible, and to time our efforts with existing work and current fire management plans. Therefore, we are requesting the second year of funding for all three projects.

Phases III-VI

Phases III-V will include third, fourth and fifth year funding for all three projects, and Phase VI will involve analyses of data and preparation of final reports.

Project Descriptions

Project 1. Effects of Fire on New Mexican Ridge-nosed Rattlesnakes in the Peloncillo Mountains.

Background. This project is the most challenging of the three due to the apparent rarity of ridge-nosed rattlesnakes in the Peloncillo Mountains, and because of the inherent controversy associated with fire planning and protection of endangered species. Previous work indicates that ridge-nosed rattlesnakes are able to survive a hot fire, but we are still uncertain as to how they use altered habitat after a fire. Our goal is to conduct surveys in burned areas in an effort to obtain as many snakes as possible that can be studied using radiotelemetry. We will focus on habitat use within burned areas to see how snakes respond to the effects of fire.

Methods. We will conduct extensive surveys in burned areas where ridge-nosed rattlesnakes have been known to occur in the past based on previous surveys. When we locate snakes, we will implant them with radiotelemeters and follow them on a daily basis throughout the active season. We will gather a variety of habitat data in areas used by snakes at three spatial scales: microhabitat (1 m around each location), home range (use versus availability within individual home ranges), and landscape (location of overall home range within the study area). We will use multivariate analyses to analyze spatial data, including logistic regression for microhabitat data, principle components analyses for within home range data, and compositional analyses for landscape level analyses.

Timeline. We will conduct limited surveys during the monsoon season in 2003 in order to determine potential study areas and to assess the feasibility of our approach. Given the apparent difficulty in finding ridge-nosed rattlesnakes, our study plan must be adaptive in nature. It is important to recognize that obtaining meaningful results that can be of direct value in fire management planning and conservation of the snake will take time and our plans may have to change as we learn more about the snakes and the environments in which they occur. In general, after the initial year of locating potential study areas, we will be on site from April-October for the next three years. The final report will be due in March 2007.

Collaborators. We have been working closely with the U.S. Forest Service, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, New Mexico Department of Game and Fish, and the

Malpai Borderlands Group to develop our research objectives and to coordinate with fire planning efforts. We have also consulted representatives from The Nature Conservancy, The Arid Lands Project, and the Animas Foundation. We feel that collaboration is critical to the success of this project given the controversy that has surrounded the complex issue of fire management and endangered species protection.

Project 2. Effects of Fire and Grazing on Grassland Herpetofauna in the Animas Valley.

Introduction. In this project, we will take advantage of comprehensive, landscape-scale research initiated in 1999 by Charles Curtin and associates on the Gray Ranch in southwestern New Mexico. The McKinney Flats work has been characterized by community-level research into the effects of fire and grazing on a variety of plant and animal assemblages. Although this work has been very successful, and results have been both interesting and useful in a management context, we see a need for more detailed research on a subset of interacting organisms. We plan to study tropic interactions between snake predators and their prey. We will accomplish this by using radiotelemetry on hog-nosed snakes and prairie rattlesnakes. We will conduct diet analyses of these species and then compare our results to baseline data on lizard and rodent prey that has been obtained by others working on site. We also plan to sample invertebrates to see if grazing and fire result in changes in abundance or diversity, and if so, does it result in cascading effects in the system. In addition, we hope to elucidate factors involved in interactions between snakes, introduced prairie dogs, and burrowing owls if the system is conducive to such analyses.

Methods. We will use primarily radiotelemetry to study snakes. All snakes will be weighed and measured, blood samples will be taken, and they will be permanently marked with passive integrated transponders (PIT-tags). Detailed information on lizard and small mammal prey are already available, as are data on plants and vegetation. We will collect fecal samples that will be compared to a reference collection of small mammal hairs and lizard scales representing species occurring on site. We have conducted diet analyses of other snake species in the past and we will be able to use much of the reference collection already constructed. We will collect scat samples from lizards that can be compared to insects captured on site. We will use sticky traps to determine diversity and relative abundance of insects on study plots before and after treatments. Because hog-nosed snakes are known to eat toads, we will also conduct toad surveys to determine relative abundance of species and to locate breeding aggregations. Spatial analyses using a geographic information system (GIS) will be performed to determine if fire or grazing may result in changes in snake home ranges. Habitat analyses will also be performed on multiple spatial and temporal scales in an attempt to better understand the effects of treatment on the manner in which snakes utilize habitat in relation to its availability.

Timeline. We will begin work in summer 2003 with the arrival of the monsoon rains. We will coordinate our efforts with ongoing herpetofauna surveys in July. This will allow us to become more familiar with the study area and existing procedures. During August surveys, we will capture and implant snakes and conduct insect sampling. After this initial field season, we will be on site on a near continuous basis from April to November of the following two years. The final report will be due in Marc h 2006.

Collaborators. We have met with Charles Curtin of The Arid Lands Project on several occasions in order to refine our study plan and to time our efforts with ongoing work. We have also had detailed discussions with Charlie Painter of the New Mexico Department of Game and Fish who is conducting

herpetofauna surveys on site. Finally, we have met with Ben Brown of the Animas Foundation and Peter Warren of The Nature Conservancy who have provided invaluable advice and assistance, as well as given us permission to work on the Gray Ranch,

Project 3. Effects of Fire on Herpetofauna in Replicated Watersheds at Cascabel Ranch.

Introduction. In this project, we will collaborate with researchers who have invested a great deal of time and money into studying the effects of fire on a variety of ecosystem processes. The study area is comprised of 12 replicated watersheds in oak savannah at Cascabel Ranch in the Peloncillo Mountains. The study is designed to determine the effects of fire on overall watershed function in an experimental context with the aid of before-after data that can be compared across treatments. Researchers have invested in sophisticated weather instrumentation, laid out monitoring grids for wildlife and plants, and conducted baseline studies of soils, vegetation and geomorphology. Our goal is to add a herpetofauna component to the overall study plan. We will achieve this by conducting surveys in all 12 watersheds before and after they are treated with fire. We will also attempt to conduct mark-recapture analyses to determine abundance of common diurnal lizard species if any occur with great enough frequency.

Methods. We will use standard time-area constrained searches to determine species diversity and relative abundance of herpetofauna. Searches will take place during morning hours when herpetofauna, especially diurnal lizards, exhibit increased activity. To conduct mark-recapture analyses, we will capture lizards using nooses. We will toe clip lizards so individuals can be identified if recaptured. For each lizard observation, we will measure a suite of habitat variables related to vegetation and geomorphological substrata in order to investigate potential explanations for changes in diversity or abundance if they should occur. Each watershed will be surveyed in spring and summer before applying the treatment, and again in spring and summer after treatment. Data will be analyzed using multivariate statistics developed for before-after-control-treatment (BACI) study designs. The most appealing aspect of this study design is the ability to obtain data on several treatment and control replicates. This allows for paired sampling, which provides the greatest power to detect changes if they should occur.

Timeline. Our goal is to gather as much pre-treatment data as possible before hydrologists calibrate the watersheds and begin burning. We are unable to determine the exact timeline because of the unpredictable nature of rainfall events in the region. We plan to obtain pre-treatment data during spring and summer to investigate potential seasonal affects. Therefore, we will obtain data in summer 2003 and spring 2004, followed by post-treatment data in summer 2004 and spring 2005. If adequate rainfall does not occur, and hydrologists are unable to obtain the required flow events, we will attempt to obtain additional pre-treatment data if funding holds out. Two years each of before and after data will only improve the study, as we will be better able to deal with the high degree of variation that occurs in the Chihuahuan Desert region. If plans to burn proceed as hoped, then the final report will be due in December 2005. If burning is delayed, then the final report will be completed 4-6 months after the final post-treatment survey period.

Collaborators. This study has numerous collaborators. Project leaders include Carl Edminster and Jerry Gottfried of the U.S. Forest Service Rocky Mountain Research Station, and Ron Bemis of the Natural Resources Conservation Service. Several university scientists, including Pete Ffolliott and Phil Guertin of the University of Arizona, are also involved. Charles Curtin of The Arid Lands Project and Ben Brown, Science Coordinator of the Malpai Borderlands Group and the Animals

Foundation have also been instrumental in the Cascabel Ranch project. The project is a model of collaborative research and it provides a unique opportunity to study effects of fire on herpetofauna.

Budget (Phase II)

The requested total budget for all three projects over the next five phases (Phase I was $20,000) is $410,000 (detailed year-by-year and project-by-project budgets available), which equals $82,000 per year for five years. In Phase II (FY03) we are requesting one fifth of total funding. The same amount will be requested each year for Fiscal Years 2004-2007.

Category	Description	FY03	UA
Personnel (ERE included)			
Principal Investigator	5.4 months @ $4000/month	21,600	
Field Biologists	8.4 months @ $2000/month	16,800	
Field Technicians	8.4 months @ $1320/month	11,040	
Office Assistant	10.8 months @ $1200/month	12,960	
Work-Study Student	10.8 months @ $ 300/month	1,800	
Total Personnel		***64,200***	
Equipment/Supplies			
Radiotelemeters. PIT tags, etc.		10,100	
Total Equipment/Supplies		***10,100***	
Travel			
Mileage	10,000 miles @ $0.33	3,300	
Lodging	80 person-nights @ $25/night	2,000	
Per Diem	80 person-days @ $30/day	2,400	
Total Travel		***7,700***	
Indirect Costs (15%)			***20,500***
TOTALS		***82,000***	***20,500***

Total Project Costs = $102,500 for FY03

Effects of Fire on Herpetofauna in the Malpai Borderlands Region: A Multifaceted Research Program

DETAILED WORK PLAN and
INTERIM PROGRESS REPORT - 2004
(USFS Agreement Number: 02-JV-11221615-279)

Submitted By:

Matt Goode, Principal Investigator
Desert Southwest Cooperative Ecosystem Studies Unit
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

May 21, 2004

Introduction

The purpose of this agreement is to conduct long-term research designed to investigate the effects of fire on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Sonora and Chihuahua. Our research program consists of three separate studies, lasting approximately three years each, phased in over the next five-six years. We are investigating single species, population, and community level effects of fire on a variety of herpetofauna. The title and brief description of each project follows. It should be noted that our research program is adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency, weather conditions, progress with the fire management plan, and the realities of field work in a highly variable environment.

1) Effects of Fire on New Mexican Ridge-nosed Rattlesnakes in the Peloncillo Mountains

In this project, we will examine the effects of fire on various aspects of New Mexican ridge-nosed rattlesnake (*Crotalus willardi obscurus*) ecology. These rattlesnakes are threatened under the Endangered Species Act, so the need to obtain information about the species that can be used to develop effective management strategies is a high priority. Furthermore, the species has been at the center of a lively debate over how to restore fire to the Peloncillos without harming the snake or its habitat. Much of this debate has been based on a paucity of ecological data. Therefore, our goal is to conduct an intensive three-year study of *C. w. obscurus* in order to learn more about their ecological requirements, and how they respond to changes associated with fire. The fire management plan for the Peloncillo Mountains is nearing finalization, with several prescribed burns scheduled over the next three years. We plan to take advantage of these prescribed burns to help elucidate the effects of fire on this rare snake.

2) Effects of Fire and Grazing on Grassland Herpetofauna in the Animas Valley

We plan to take advantage of ongoing, landscape-scale research being conducted by Charles Curtin (Arid Lands Project) and associates at McKinney Flats on the Gray Ranch. We will examine the effects of fire on a variety of herpetofauna in a manipulative context. We will focus on hog-nosed snakes (*Heterodon nasicus*) and prairie rattlesnakes (*Crotalus viridis*), two common grassland species. We will use radiotelemetry to study movement patterns and habitat use as it relates to different treatment types (fire, grazing, fire and grazing in combination, and neither fire or grazing). We will tap into existing datasets on species diversity and relative abundance of herpetofauna and small mammals to investigate the manner in which snakes are affected by changes in their prey base. We will determine diet of snakes based on fecal analyses and feeding observations. Because toads are known be a primary food source of hog-nosed snakes, we will also monitor toad breeding aggregations to see if we can document hog-nosed snake predation at these sites. Investigating the effects of fire and grazing on ecological processes such as predator-prey interactions is widely recognized as important, but is seldom addressed

3) Effects of Fire on Herpetofauna in Replicated Watersheds at Cascabel Ranch

In this project, we plan to take advantage of a long-term study at Cascabel Ranch, on the eastern edge of the Peloncillo Mountains, where Jerry Gottfried (US Forest Service) and associates are conducting research on the effects of fire on hydrological regimes. At Cascabel Ranch, several watersheds have been instrumented and will be calibrated when sufficient monsoon rains occur. We plan to use a

before-after-control-impact (BACI) study design with paired sampling to analyze data obtained from herpetofauna surveys of these watersheds. We will obtain baseline data on species composition and relative diversity of amphibians and reptiles in several watersheds prior to burning. These data will be compared to post-burn surveys of both burned and unburned watersheds in order to assess the effects, if any, that fire has on resident herpetofauna. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna.

Phase I

Phase I of this research program is completed. Our objectives in the initial phase were to (1) conduct snake surveys and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna.

From September to November 2002, we surveyed for montane snakes in burned and unburned areas in the Sierra San Luis. Concurrently, we identified sites for long-term radiotelemetry studies in both burned and unburned areas. Unfortunately we were unable to obtain Mexican permits authorizing us to initiate radiotelemetry. Matt Goode will no longer be the principal investigator on the work being conducted in the Sierra San Luis. Instead, Gary Belovsky at the University of Notre Dame will be the principal investigator. According to Kirk Setser, graduate student in charge of fieldwork on the project, Mexican permits should be obtained prior to summer 2003, at which time radiotelemetry based work will proceed. We were also unable to characterize snake habitat. We felt that data from snake encounters would be biased because we chose to look for snakes where we thought we would have the best chance of finding them. Therefore, as part of the Sierra San Luis study, data from snakes monitored with radio transmitters will be used for habitat quantification.

During our surveys in the Sierra San Luis, we inspected three burned and three unburned sites on the western slope of the range. We also briefly investigated three unburned areas on the eastern slope. We found 24 individual snakes, comprising seven species. Of the three focal species, we found no *Crotalus lepidus*, eight *C. willardi*, and two *Lampropeltis pyromelana*. We found *C. willardi* at both burned and unburned sites. *Lampropeltis pyromelana* were only encountered at an unburned area.

We spent considerable time meeting with key players involved in the Peloncillo Mountains Fire Management Plan, including members of the Malpai Borderlands Group, Animas Foundation, The Nature Conservancy , US Forest Service, Arizona Game and Fish Department, New Mexico Department of Game and Fish, and US Fish and Wildlife Service. Specifically, we attended the Malpai Borderlands Group Board of Directors Meeting on October 17th and participated in meetings with the Snake Advisory Group panel in late October. During these trips, as well as during another trip with Peter Warren of the Nature Conservancy in early October, we examined the experimental plots at McKinney Flats and Cascabel Ranch. In April 2003, we attended the Technical Advisory Visit organized by Carl Edminster in Douglas, Arizona and at the Malpai Borderlands Group offices at the Glenn Ranch east of Douglas. At this meeting, we had the opportunity to address meeting participants about our research program, and to discuss project design and logistics with numerous key collaborators. We received excellent input those involved, made important contacts with other

investigators, and obtained information about timing of ongoing projects that was necessary for us to develop our plans further.

Phase II

As stated in the 2003 Work Plan, our objectives were to 1) begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch; 2) initiate radiotelemetry studies of snakes at McKinney Flats; and 3) conduct limited surveys for ridge-nosed rattlesnakes in previously burned However, because we did not receive funding until mid-August, and because our USFWS Endangered Species Permit was not approved until late August, we were forced to delay or postpone field-related aspects of Phase II objectives. However, this was not a significant problem, because we found that additional consulation and planning was required before moving forward with research related to fire and ridge-nosed rattlesnakes given the complexity of issues involved. In addition, there was no urgency to conduct pre-treatment surveys at Cascabel Ranch due to the lack of precipitation events required to "calibrate" the watersheds for research related to effects of fire on hydrological function. In addition, it was decided by the ad hoc snake advisory team that radiotelemetry research on ridge-nosed rattlesnakes was not an immediate priority, meaning that objective 2 above was changed.

Currently, much progress had been made on Phase II. We are nearly half way through with our spring surveys at Cascabel Ranch. Spring surveys will be completed in early June and summer surveys will be conducted in July, August and September.

We made three trips to McKinney Flats in order to further discuss our study plan with Charles Curtin, and to assist with his lizard sampling efforts. During our visits, we developed our study plan in conjunction with Charles Curtin and Charlie Painter of New Mexico Department of Game and Fish. This year we have made three trips to McKinney Flats to install drift fences and funnel traps that we hope will enable us to capture hog-nosed snakes and prairie rattlesnakes that can be used in our radiotelemetry study. Currently, we have installed 96 10-foot drift fences in each of four study plots at McKinney Flats, and we will be opening funnel traps in early June. We will be implanting radiotelemeters into snakes as they are captured, and then we will track them until they go into their winter dens. In addition, we will be helping Charles Curtin with lizard sampling and his crew will be assisting us with capturing and tracking snakes. In this manner, we can both reduce the costs of conducting research.

We were unable to conduct ridge-nosed rattlesnake surveys in 2003, because USFWS was slow in processing our endangered species permit. In addition, the ad hoc snake advisory team suggested that we spend time trying to improve capture rates of these elusive snakes using drift fences and funnel traps. This past spring we installed 16 100-foot drift fences in two canyons in the Peloncillo Mountains where the most snakes were captured by Andy Holycross and colleagues. It is our hope that we can greatly improve on the abysmal capture rate of one snake every 33 person-days obtained by Holycross and colleagues conducting foot searches. If we can capture significantly more snakes per unit effort using drift fences and funnel traps, that will open the door for potential research (e.g., radiotelemetry) and for monitoring presence/absence in potential snake habitat.

This year we also met with Trevor Hare of Sky Island Alliance to plan five volunteer trips to search for ridge-nosed rattlesnakes in potential snake habitat recommended by Andy Holycross and Charlie Painter. We have been told by Coronado National Forest personnel (including Doug Hardy, Gary

Helbing, and Pete Gordon) that they are interested in whether or not potential habitat polygons are occupied or not, because this will aid in the design and implementation of future prescribed burns. We feel that this new objective is a worthwhile one, because it provides the Forest Service with practical information that can be used directly in fire planning.

Finally, we have added an additional objective at the request of Carl Edminster and Forest Service personnel from the Douglas Ranger District. This objective involves a more thorough assessment of the effects of the Baker II Burn on potential snake habitat. Gary Helbing and Peter Warren (TNC) flew over the burn in helicopter and mapped fire intensity for the entire burn. However, CNF personnel felt that it was important to more precisely quantify fire intensity within potential snake habitat. We have visited several affected polygons this past spring and have developed a plan for assessing the effects of the burn on potential snake habitat. We plan to visit all affected polygons (ca. 20) and map different burn intensity areas using GPS units. We also plan to take photographs to document the effects of the burn on potential snake habitat, and we will repeat pre-fire habitat measurements made by Andy Holycross and colleagues. We hope to not only describe the effects of the Baker II Burn on potential habitat, but to develop recommendations for how to quantify fire effects before and after future prescribed burns.

Most of the objectives discussed above were presented at the Malpai Borderlands Group Science Meeting in January of 2004, although some objectives have been modified or added since receiving input from interested parties.

All in all, Phase II has been successful, but due to constraints discussed above, our timetable has been set back several months so that we are still busy conducting Phase II tasks, but also beginning to move into Phase III. In addtion, due to funding constraints and timing of available funds, we are now requesting additional funding to continue with Phase II and to begin Phase III.

Budget

The requested total budget for the entire project is $410,000 (detailed year-by-year and project-by-project budgets available), which equals $82,000 per year for five years. In Phase I, we received approximately $20,000. In Phase II (FY03) we received approximately $90,000 for a total of $110,000. We are now requesting $65,000 to bring us to a total of $175,000. Next year, we will request an additional $71,000 to bring us up to a total of $246,000, which is the entire amount promised for Phases I-III. In Phases IV-V, we will request $82,000 for the next two years bringing the total for the entire project to $410,000 as originally agreed to. Although the project timeline may change, we do not anticipate any budget changes at this time.

Budget

Category	Description	FY03	UA
Personnel (ERE included)			
Principal Investigator	5.4 months @ $4000/month	21,600	
Field Biologists	8.4 months @ $2000/month	16,800	
Office Assistant	10.8 months @ $1200/month	12,960	
Work-Study Student	10.8 months @ $ 300/month	1,800	

Total Personnel		***53,160***	
Equipment/Supplies			
Radiotelemeters, PIT tags, etc.		4,000	
Total Equipment/Supplies		***4,000***	
Travel			
Mileage	12,000 miles @ $0.345	4,100	
Lodging	80 person-nights @ $25/night	2,000	
Per Diem	80 person-days @ $30/day	2,400	
Total Travel		***8,600***	
Indirect Costs (25%)			***16,440***
TOTALS		***65,760***	***20,500***

Effects of Fire on Herpetofauna in the Malpai Borderlands Region: A Multifaceted Research Program

PHASE II ANNUAL REPORT – 2004
PHASE III WORK PLAN – 2005

Submitted By:

Matt Goode, Principal Investigator
School of Natural Resources
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

December 10, 2004

Introduction

The purpose of this agreement is to conduct long-term research on the effects of fire on herpetofauna in the Malpai Borderlands region of southeastern Arizona, and southwestern New Mexico. We are investigating single species, population, and community level effects of fire and grazing on a variety of herpetofauna at sites in the Peloncillos Mountains and the Animas Valley. It should be noted that our research program is adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency, weather conditions, progress with the fire management plan, and the realities of field work in a highly variable environment.

Our research program consists of three separate studies, lasting approximately three years each, phased in (five phases total) over the next five-six years. Phase I was completed in 2002-2003. This past field season, we completed the field portion of Phase II, and we are now compiling and analyzing data, writing progress reports, and planning for next field season. Phase III will begin in 2005 when the field season gets underway and we receive the next round of funding. In this report, we discuss our results to date and we present our work plan for 2005 (Phase III). Below, we provide a brief description and specific objectives of each project.

1) Effects of Fire on New Mexican Ridge-nosed Rattlesnakes in the Peloncillo Mountains

In this project, we are examining the effects of fire on various aspects of New Mexican ridge-nosed rattlesnake (*Crotalus willardi obscurus*) ecology. These rattlesnakes are threatened under the Endangered Species Act, so the need to obtain information about the species that can be used to develop effective management strategies is a high priority. Furthermore, the species has been at the center of a lively debate over how to restore fire to the Peloncillos without harming the snake or its habitat. Much of this debate has been based on a paucity of ecological data. Therefore, our overall goals were to see if drift fence trapping would enable us to find more snakes, thereby making concerted research (e.g., radiotelemetry and habitat analyses) efforts more feasible, and to determine if snakes were present in canyons where they have not been documented to aid in fine tuning the fire management plan and aid in the application of fire to the landscape.

Specific Objectives:

- Use funnel traps in an effort to increase capture success
- Compare results of simultaneous foot searches to trap success in canyons with funnel traps
- Determine new localities by surveying canyons identified as more likely to have rattlesnakes
- Use Sky Island Alliance volunteers to increase person-hours searching for rattlesnakes
- Conduct road cruising surveys along Geronimo Trail that runs through occupied habitat
- Obtain locality data on all amphibian and reptiles encountered over course of the field season
- Process (weigh, measure, etc.) all snakes captured regardless of species
- Conduct post-burn assessment of effects of Baker II fire on potential rattlesnake habitat

2) Effects of Fire and Grazing on Grassland Herpetofauna in the Animas Valley

We are taking advantage of ongoing, landscape-scale research conducted by Charles Curtin and other investigators at McKinney Flats on the western division of the Diamond A Ranch. Our original goal was to assess the effects of fire and grazing on hog-nosed snakes (*Heterodon nasicus*) and prairie rattlesnakes (*Crotalus viridis*), two common grassland species. Although we are conducting intensive

autecological research on prairie rattlesnakes, we are no longer studying hog-nosed snakes, because it is difficult to find individuals that are large enough to carry transmitters. Besides rattlesnake radiotelemetry, we are now gathering a wealth of data on the snake community present at McKinney Flats. We originally used drift fences and funnel traps to capture focal species, but it became immediately apparent that we would also be able to trap large numbers of several other species. Therefore, our we will continue to sample for snakes using our existing funnel trap arrays, which consist of nearly 400 traps spaced along 100 drift fences in each of four experimental pastures. We are also capturing large numbers of lizards in our traps, and we plan to compare our capture rates with those of Curtin and his colleagues.

Specific Objectives:

- Conduct radiotelemetry study of prairie rattlesnakes to determine response to grazing and fire
- Obtain data on snake community using drift fences and associated funnel traps
- Determine trophic interactions of snakes by examining diet based on fecal analyses
- Compare lizard capture rates of funnel traps and pitfalls
- Continue to work together with Charles Curtin and associates to increase cost effectiveness
- Determine associations of environmental data (e.g., rainfall, soil) with snake community structure

3) Effects of Fire on Herpetofauna in Replicated Watersheds at Cascabel Ranch

In this project, we are taking advantage of a long-term study at Cascabel Ranch, on the eastern edge of the Peloncillo Mountains, where Jerry Gottfried (US Forest Service) and associates are conducting research on the effects of fire on hydrological regimes. At Cascabel Ranch, several watersheds have been instrumented and will be calibrated when sufficient monsoon rains occur. We plan to use a before-after-control-impact (BACI) study design with paired sampling to analyze data obtained from herpetofauna surveys of these watersheds. We have obtained one year of baseline data on species composition and relative diversity of amphibians and reptiles in several watersheds prior to burning. Next year, we will continue to obtain baseline data that we will compare to post-burn surveys of both burned and unburned watersheds. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna.

Specific Objectives:

- Survey watersheds (12 watersheds, 3 plots each) twice each in spring and twice each in summer
- Determine species diversity, evenness, relative abundance and demography of herpetofauna
- Obtain microhabitat data on common lizards species
- Examine relationship of lizards to their environment (e.g., vegetation, soil, temperature, rainfall)
- Compare pre- and post-burn data in an experimental framework

Phase I

Phase I of this research program is completed. Our objectives in the initial phase were to (1) conduct snake surveys and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna. Matt Goode is

no longer involved in work being conducted in the Sierra San Luis. Gary Belovsky at the University of Notre Dame is the principal investigator, and Kirk Setser is his graduate student in charge of fieldwork.

Phase II

Most of the objectives of Phase II were presented at the Malpai Borderlands Group Science Meeting in January of 2004, although some objectives have been modified or added since receiving input from interested stakeholders. Phase II has been successful, however, due to constraints discussed above, our timetable has been set back several months, but we are now planning for Phase III.

As stated in the 2003 Work Plan, our objectives were to 1) begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch; 2) initiate radiotelemetry studies of snakes at McKinney Flats; and 3) conduct limited surveys for ridge-nosed rattlesnakes in previously burned However, because we did not receive funding until mid-August, and because our USFWS Endangered Species Permit was not approved until late August, we were forced to delay or postpone field-related aspects of Phase II objectives. However, this was not a significant problem, because we found that additional consultation and planning was required before moving forward with research related to fire and ridge-nosed rattlesnakes given the complexity of issues involved. In addition, there was no urgency to conduct pre-treatment surveys at Cascabel Ranch due to the lack of precipitation events required to "calibrate" the watersheds for research related to effects of fire on hydrological function. In addition, it was decided by the ad hoc snake advisory team that radiotelemetry research on ridge-nosed rattlesnakes was not an immediate priority, meaning that our objectives changed.

After a great deal of discussion and planning, we were finally able to conduct Phase II field work in the spring of 2004. We began all three projects, which meant that several people were working in the field at different sites. It was a very busy and productive field season. Although this report represents the culmination of Phase II, we may still change our objectives based on discussions with the funding agency and relevant stakeholders. We hope to address several issues and ideas with a variety of people at the upcoming Malpai Borderlands Group Science Meeting in January to further refine our objectives.

Study Design and Methods

Ridge-nosed Rattlesnake Project

We were unable to conduct ridge-nosed rattlesnake surveys in 2003, because USFWS was slow in processing our endangered species permit. In addition, the ad hoc snake advisory team suggested that we spend time trying to improve capture rates of these elusive snakes using drift fences and funnel traps. In the spring of 2004, we installed 15 drift fences and 78 funnel traps in two canyons in the Peloncillo Mountains where the greatest number of rattlesnakes were captured by Andy Holycross and colleagues. Our goal was to improve on the capture rate of one snake every 33 person-days obtained by Holycross and colleagues conducting foot searches. We knew that we would need to dramatically increase number of snakes per unit effort to make future research possible. We conducted foot searches concomitant with trapping efforts to enable more reasonable comparisons between the two techniques.

In addition to our trapping efforts, we also spent a great deal of time looking for ridge-nosed rattlesnakes in canyons that seemed promising, but from which no snakes were documented. Besides two full-time field technicians who spent nearly 500 person-hours searching for rattlesnakes, we also received a great deal of volunteer help from Sky Island Alliance. We made three trips (8 days total) with Sky Island Alliance volunteers. We searched for ridge-nosed rattlesnakes in potential snake habitat recommended by Andy Holycross and Charlie Painter. We have been told by Coronado National Forest personnel (including Doug Hardy, Gary Helbing, and Pete Gordon) that they are interested in whether or not potential habitat polygons are occupied or not, because this will aid in the design and implementation of future prescribed burns. Although this was a worthwhile objective, because it provides the Forest Service with practical information that can be used directly in fire planning, our results were disappointing.

To further increase our chances of finding ridge-nosed rattlesnakes, we conducted road cruising surveys along Geronimo Trail where snakes have been encountered in the past. We did not find a single ridge-nosed rattlesnake in over 400 miles of driving.

Last winter, Carl Edminster and Forest Service personnel from the Douglas Ranger District suggested that we add the objective of assessing in more detail the extent to which the Baker II Burn affected potential snake habitat. Gary Helbing and Peter Warren (TNC) had flown over the burn in a helicopter and mapped fire intensity for the entire burn. However, CNF personnel felt that it was important to more precisely quantify fire intensity within potential snake habitat. At first, we were not allowed access into burned areas in the vicinity of Cloverdale, because private landowners are planning on closing road in the area. However, in late summer, we were given permission to visit sites in this area. We visited several affected polygons and developed a plan for assessing the effects of the burn on potential snake habitat. However, given funding constraints, we are uncertain if this objective will still be a high priority. If we go through with the work, we plan to visit all affected polygons (ca. 20) and map different burn intensity areas using GPS units. We also plan to take photographs to document the effects of the burn on potential snake habitat, and to repeat pre-fire habitat measurements made by Andy Holycross and colleagues. Although our efforts are hampered by the lack of good baseline data (points at which habitat was measured were not recorded), we may be able to not only better describe the effects of the Baker II Burn on potential habitat, but to develop recommendations for how to quantify fire effects before and after future prescribed burns.

McKinney Flats Project

We made three trips to McKinney Flats in order to further discuss our study plan with Charles Curtin, and to assist with his lizard sampling efforts. During our visits, we developed our study plan in conjunction with Charles Curtin and Charlie Painter of New Mexico Department of Game and Fish. This past spring, we installed drift fences and funnel traps (ca. 400) that we hoped would enable us to capture hog-nosed snakes and prairie rattlesnakes for a radiotelemetry study. However, not only did they capture the snakes we needed for telemetry, they also captured over 600 individuals of 18 species.

We constructed a single drift fence/funnel trap array in each of the 4 pastures on McKinney Flats. We arranged the trap arrays in a "T" pattern within the grazing exclosures on each pasture. The arrays consisted of 23-24 thirty-meter lengths of 61-cm high, 6.3-mm opening galvanized hardware cloth with a 30-m gap between fence sections. We buried the drift fence sections 15 to 20 cm into the ground and we used rebar stakes for additional support. We placed four funnel traps on each section

of fence; two on each end, on opposite sides of the fence facing the center of the fence. The long axis (1000 m) of the array ran along the interface between the grazed and the grazing release (non-grazed) interface on each study plot, just within the exclosure fence. The short axis of the "T" (500 m) ran along the interface between the burned and unburned treatments within the exclosure. Each long axis consisted of approximately 16 sections of fence and 64 funnel traps, while each short axis consisted of approximately 8 sections of fence and 32 traps. The number of sections varied due to unsuitability of some areas for fence (e.g. washes, soil type, etc.).

We constructed funnel traps using redwood (1.9 cm X 2.0 cm) and 3-mm opening galvanized hardware cloth; each trap measured 60 cm long, 40 cm wide and 20 cm high. We built the traps in a box form, with a hinged lid on top to facilitate the removal of lizards and venomous snakes. We inserted a funnel (made from the same hardware cloth) into one end of each trap. Funnel openings were 4 – 6 cm in diameter. We also placed a 1.25 cm thick piece of foam insulation in each trap lid as a shade for trapped animals. The trap design also reduced the time needed to check the traps and increased the life of the traps due to decreased stress on the trap.

We opened trap arrays on 8 June and ran them continuously until 29 Sept. We opened them from 5 October until 7 October and again from 12 October until14 October. We checked our traps daily (each morning) while they were open. This reduced the possibility of animal fatality due to desiccation and predation. We transported all captured snakes back to camp for processing. We marked each snake individually with a PIT tag (except for the smaller species). We also weighed, measured SVL and tail length, measured head length and width, and palpated for food boli and fecal material. If we palpated a fresh bolus (identifiable shape), we moved the bolus into the mouth of the snake, using reverse peristalsis, for identification. Additionally, we obtained fecal samples from all animals that had fecal material present. We also palpated females for reproductive condition (eggs, embryos, follicles).

Our radiotelemetry work got off to a great start in 2004, as we were able to obtain numerous snakes for implantation, and track them from June-November. We are tracking snakes once per month during the winter to see if we can observe any unexpected winter activity.

We are implanting radiotelemeters into selected prairie rattlesnakes (*Crotalus viridis*) and hog-nosed snakes (*Heterodon nasicus kennerlyi*). We have been selecting snakes based on size and sex. We hope to obtain a sample of 7 males, 7 gravid females, and 7 non-gravid females. We originally used 1.8-gram radios so we could implant smaller hog-nosed snakes, however, we experienced several radio failures and had trouble finding hog-nosed snakes that were large enough. Therefore, in September we began replacing the radios in prairie rattlesnakes with 5-gram units. We removed the 1.8-gram radios from hog-nosed snakes that we could still locate (radios failed in some snakes) due to the small sample size, and concentrated on prairie rattlesnakes. We attempted to locate each telemetered snake daily. At each location we recorded temperature and relative humidity at ground level, at 1 cm above the ground, and at 1 m above the ground. We also recorded dominant vegetation and cover in a $1m^2$ and 10 m^2 area around the snake, and any behaviors exhibited by snakes.

Cascabel Ranch Project

We completed spring (pre-monsoon) and summer (monsoon) surveys at Cascabel Ranch. We randomly located three one-hectare plots in each of 12 watersheds. We surveyed all three plots during the morning hours during peak activity of common diurnal lizards. Two to three people surveyed

each morning. We surveyed each plot for one hour for a total of three hours per morning. We surveyed all 12 watersheds three times each during pre-monsoon and monsoon sampling periods. In total, we surveyed each plot 3 times for a total of 36 plots surveyed 216.

To observe as many lizards as possible during surveys, we used a combination of techniques. In general, we walked slowly, scanning and listening for moving lizards. We used binoculars to observe basking lizards from a distance to avoid causing them to escape before we could get close enough to identify them. We used mirrors to reflect sunlight into cracks and crevices in an effort to observe lizards in shelters.

Our results are confined primarily to diurnal lizard species, because we find them in large numbers allowing for robust statistical analyses. We do find snakes, toads and turtles occasionally, although we only include them in analyses of community composition and not for estimates of relative abundance.

Results and Discussion

Because our results are incomplete, we are presenting only the highlights of our research to date. Although we have obtained a great deal of data, much of it is preliminary. Future analyses will be much more rigorous and include a more detailed statistical treatment of the data.

Ridge-nosed Rattlesnake Project

Over the course of the entire field season, from mid-May to mid-September, we were able to find a total of three ridge-nosed rattlesnakes in spite of a great deal of time and effort spent looking. It appears as if these elusive snakes are extremely rare indeed, and that conducting meaningful, cost-effective research on a reasonable sample of individuals is probably not possible. Although our efforts did produce a reasonable number of snakes other than ridge-nosed rattlesnakes, we believe the Peloncillo Mountains are generally depauperate of herpetofauna relative to other mountain ranges in the region.

In total, using all methods combined (i.e., trapping, road cruising, foot searches and incidental observations), we captured 63 snakes comprising 10 species. Of the total, 27 were rattlesnakes and 37 were non-venomous colubrids. Black-tailed rattlesnakes were by far the most common rattlesnake species (n = 21), and Sonoran whipsnakes were the most common non-venomous snake (n = 14). We also captured three banded rock rattlesnakes, a protected species in Arizona.

We also observed 335 lizards comprising 11 species during the course of the field season by all methods combined. Most notably, we observed three mountain skinks and two short-horned lizards; both species are listed by the Forest Service as sensitive species. The most common lizard species observed was the tree lizard. In addition, we observed 13 mud turtles, 19 toads, and approximately 400 tadpoles.

Between July 8 and September 17, we operated 70 funnel traps for 6 days and 78 funnel traps for 44 days for a total of 3852 trap-days. Our efforts produced two ridge-nosed rattlesnakes, one in a trap and one crawling along the drift fence a few meters from a trap. In total, we captured 32 snakes, which we recaptured 7 times. The most common snake was the Sonoran whipsnake (n = 12). We also captured four Arizona mountain kingsnakes, one of which was a recapture originally captured by

Holycross and associates. These colorful snakes are worth mentioning, as they are highly prized in the pet trade and may be heavily poached in areas throughout their range.

We also captured 83 lizards in our traps, but we only recaptured two individuals. The most common lizard species we captured were Sonoran spotted whiptails (n = 22) and Chihuahuan spotted whiptail (n = 21). In addition, we captured three red-spotted toads in our funnel traps.

In our opinion, funnel traps hold little promise for obtaining significant numbers of ridge-nosed rattlesnakes for research or monitoring purposes. Our trap success rate was an abysmal 0.05%. Put another way, it would take about 25 days to capture one snake using 78 traps per day. Although not directly comparable, we did spend 44 person-hours conducting foot searches in the same canyons where our traps were located. In addition, we spent approximately 150 person-hours checking traps, which often involved active searching in prime habitat as we moved from one trap array to the next. Our foot search effort did not produce a single ridge-nosed rattlesnake, so compared to funnel traps, capture success was even worse. Obviously, trapping is a very ineffective means of capturing ridge-nosed rattlesnakes, although it may be slightly more productive, in terms of days needed to capture a snake, than foot searches. However, when costs are figured in, both methods are extremely cost ineffective and impractical.

From May 31 to September 17, we conducted 39 foot searches in potential ridge-nosed rattlesnake habitat for a total of 495 person-hours (approximately 62 person-days). During this time, we obtained one ridge-nosed rattlesnake that was found by a Sky Island Alliance volunteer while hiking on a trail away from known potential snake habitat. The area where the snake was found was not typical of potential ridge-nosed rattlesnake habitat in that it was on an exposed, rocky, grassy slope a long distance from any mapped polygons of potential habitat. Although only a sample size of one, we began conducting more searches in open, rocky and grassy high elevation slopes and ridges. However, we did not observe any other ridge-nosed rattlesnakes during foot searches.

In total, we observed 17 snakes during foot searches away from the two canyons where our traps were located. Of these 17 snakes, only one was a ridge-nosed rattlesnake. This translates into one snake every 29 hours (3.6 person-days), and only one ridge-nosed rattlesnake every 495 hours (62 person-days). In addition, we only found six snakes while road cruising and 12 snakes incidentally, and none of these were ridge-nosed rattlesnakes. Again, we conclude that ridge-nosed rattlesnakes in the Peloncillo Mountains are extremely difficult to find, thus severely limiting or even eliminating any meaningful ecological research on the species.

McKinney Flats Project

We captured 622 different snakes comprising 18 different species during the field season with total captures (including recaptures) equaling 1034 snakes. We captured 917 (89%) of these snakes in our trap arrays. We made the balance of the captures while tracking telemetered snakes (n = 39, 4%), driving roads (14, 1%), walking transects (10, 1%), finding snakes along the drift fence (15, 1%), or by other incidental means (37, 4%). We ran our traps for a total of120 array nights (43,920 trap nights); mean snakes per array night was 7.6.

We divided our captures into five areas; NE, NW, SE, and SW pastures of McKinney Flats, and Culberson. The Culberson area was comprised of the region east of McKinney Flats and west of the wash behind the Culberson bunkhouse. Because we did not include this area in our arrays, all snakes

Species	Number of Individuals Captured
Pituophis catenifer	106
Masticophis flagellum	105
Salvadora hexalepis	63
Crotalus viridis	60
Crotalus atrox	56
Heterodon nasicus	49
Lampropeltis getula	34
Thamnophis cyrtopsis	32
Hypsiglena torquata	27
Salvadora grahamiae	22
Rhinocheilus lecontei	21
Arizonal elegans	14
Gylopion canum	10
Masticophis bilineatus	10
Sonora semiannulata	7
Tantilla nigriceps	4
Crotalus lepidus	1
Tantilla hobartsmithi	1

we captured in this area were caught while driving the roads or by other incidental means. We captured 603 of the 622 individuals (97%) in the four pastures on McKinney Flats. We captured the highest number of individuals (n = 200, 34% of pastures total) as well as the greatest number of species (16) in the northeast pasture. We captured 170 different snakes from 13 species in the southwest pasture (28%); 122 (14 species) in northwest pasture (20%), and 111 (13 species) in southeast pasture (18%). No two pastures had the same species assemblage but the Shannon diversity index was similar for each of the four pastures (NE = 2.31, SE = 2.23, NW = 2.20, SW = 2.10).

We finished the season with 16 telemetered *C. viridis* - 10 females and 6 males. We only had telemetered snakes in northeast and southeast pastures, a function of their distribution. We captured 60 total *C. viridis* in the four pastures, 31 in NE (51.7%), 22 in SE (36.7%), 4 in SW (6.7%), and 3 in NW (5%). Ten of the telemetered snakes were in the northeast pasture (4 males and 6 females).

Overall, males had a larger homerange MCP, larger 95% Fixed Kernel Home Range (FKHR), longer mean, maximum, and total distance moved. The mean 50% FKHR core activity area for males (1.9 ha) was not significantly larger than the female mean 50% Fixed Kernel area (1.4 ha) after CRVI 011 was removed from the analysis (P = .13). These results are based on calculations done with CRVI 011 (a male) removed from the analysis.

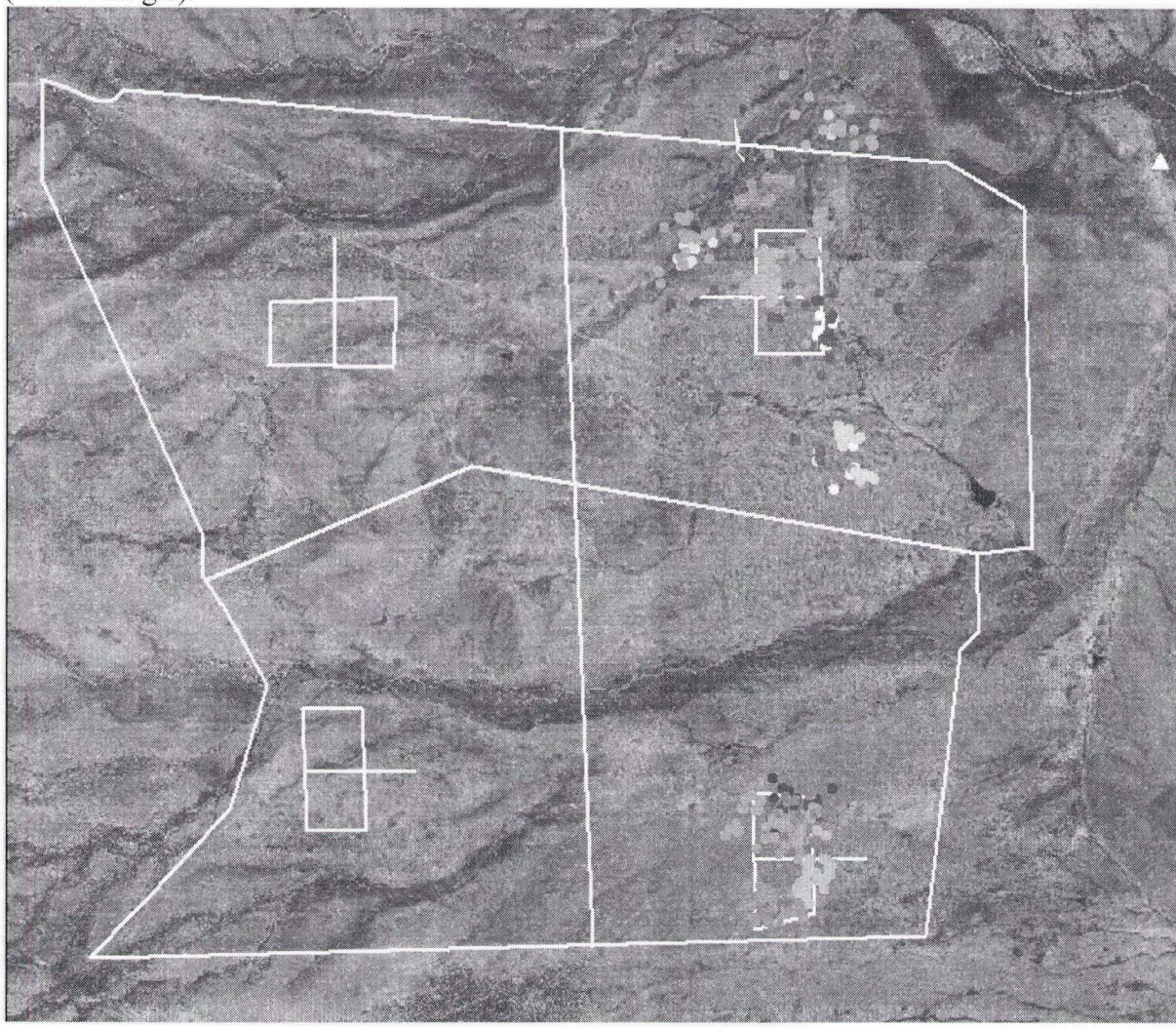
Female Prairie Rattlesnakes

SnakeID	95% area m^2	95% area ha	50% area m^2	50% area ha	Mean Distance Moved (m)	Max. Distance Moved (m)	Min. Distance Moved (m)	Total Distance Moved (m)	MCP area m^2	MCP area ha	Sample Size
CRVI 003	76,925	8	10799	1.1	39	261	0	2805	55626	6	73
CRVI 004	84,272	8	9848	1.0	30	226	0	2301	131584	13	79
CRVI 005	257,830	26	22767	2.3	53	427	0	4096	241329	24	78
CRVI 009	112,673	11	13011	1.3	36	223	0	2400	84265	8	68
CRVI 017	143,117	14	35321	3.5	46	263	0	1524	105547	11	35
CRVI 024	15,110	2	2585	0.3	36	168	0	1129	15797	2	32
CRVI 025	37,010	4	5284	0.5	36	157	1	1020	26451	3	29
CRVI 027	104,772	10	8683	0.9	42	190	0	1345	83456	8	33
Avg.	103,964	10	13,537	1.4	39	239	0	2078	93007	9	
SD	74,432	7	10,642	1	7	85	0	1043	71315	7	

Male Prairie Rattlesnakes

SnakeID	95% area m^2	95% area ha	50% area m^2	50% area ha	Mean Distance Moved (m)	Max. Distance Moved (m)	Min. Distance Moved (m)	Total Distance Moved (m)	MCP area m^2	MCP area ha	Sample Size
CRVI 001	340,205	34	25,269	2.5	132	881	0	7142	553623	55	55
CRVI 007	373,827	37	24,719	2.5	119	550	0	6642	315606	32	57
CRVI 008	99,050	10	7,529	0.8	96	712	0	4819	182637	18	51
CRVI 010	249,318	25	17,173	1.7	95	565	0	4728	342043	34	51
CRVI 014	273,985	27	26,674	2.7	123	534	0	3070	291598	29	26
AVG	265,600	27	18,673	1.9	110	677	0	5833	348477	35	
SD	122,859	12	8,297	0.83	18	154	0	1241	153525	15.35	

Overview of McKinney Flats showing locations of telemetered prairie rattlesnakes (various colored dots; N = 16), the four pastures with grazing exclosures (white outlines), and the Culberson house (white triangle).



This season the large number of snakes we captured surprised us. We started with the goal of examining effects of burning and grazing on prairie rattlesnakes and hog-nosed snakes using radiotelemetry. We installed the trapping array system in order to obtain snakes for the telemetry study. However, the huge number of captures and recaptures has provided us with a one-of-a-kind data set about a diverse snake assemblage. The data we have obtained on the snake community is unprecedented. We hope to obtain data over the next two years to examine annual and seasonal variation in snake abundance, demography, diet, growth and reproduction. In addition, our data will add to our knowledge of how fire and grazing affect ecological processes in Chihuahuan Desert grasslands, including trophic interactions and response to environmental change, as revealed by combining our data with data already gathered on site.

Charles Curtin and colleagues are planning to burn McKinney Flats in late spring or early summer 2005. In addition, they are planning to restock the area with cattle in the fall of next year. The rains during the summer of 2004 led to a prolific herbaceous growth in biomass. The burn in 2005 will be the first significant burn of the area since 1998. We will continue to locate our telemetered animals

and bring the sample size up to 21 total snakes (7 from each adult demographic). We will also continue to run the trapping array and gather data on snakes that use McKinney Flats. In the late fall of 2004 we began distance sampling of rodent burrows and kangaroo rat mounds (refugia for snakes), and will finish this spring/summer. We will also be looking at, and gathering data on, other physical, environmental and biological factors that might influence snake distribution, growth, reproduction and diet of the snakes we capture on McKinney Flats.

Cascabel Ranch Project

We spent a total of 48 person-days conducting surveys in the watersheds at Cascabel Ranch. Our efforts have resulted in a large data set on several common diurnal lizards species that use the arroyos. In total, we observed 2707 lizards comprising 8 species, 7 snakes comprising 3 species, 4 turtles comprising one species, and 3 toads comprising one species. During the pre-monsoon season, we observed 2002 lizards compared to 705 during the monsoon season. The substantial decrease in relative abundance is likely due to the relative paucity of whiptail lizards during the summer rainy period when temperatures are somewhat lower. Also, an increase in cloudy and rainy days tends to dampen lizard activity, although we did not survey on days with excessive cloud cover or during rain.

We are concentrating our analyses on the lizard community at Cascabel Ranch. The most common lizard species during the pre-monsoon period was the Sonoran spotted whiptail (n = 725), followed closely by the tree lizard. (n = 675). During the monsoon season, Sonoran spotted whiptails (n = 257), and tree lizards (n = 255) were equally abundant (n = 675). In late spring we observed 6 species of lizards, and during the summer, we observed 8 species (three mountain spiny lizards and one short-horned lizard comprised the two additional species).

This coming year, we will continue to gather data on the lizard community at Cascabel Ranch. This will enable us to compare before and after data on the effects of fire on relative abundance, species diversity, evenness, and population structure of lizards observed. By collecting data over multiple years, we will have a better idea of the effects of annual variation on lizard ecology. The existence of a wealth of data on the physical and biotic environment at Cascabel Ranch that has been mostly gathered by Forest Service personnel, will allow us to examine underlying causes leading to the relationship between lizard ecology and fire.

Conclusions

We had a very successful field season in 2004, and we have conducted preliminary analyses of our data. We feel strongly that the McKinney Flats Project and the Cascabel Ranch Project have been extremely valuable. We have obtained an unprecedented data set on the snake community at McKinney Flats. In addition, we have been very successful in obtaining and monitoring prairie rattlesnakes, and we are excited about the prospects of examining the effects of fire on rattlesnakes this spring, and of grazing later this year and next. Our data set on lizards at Cascabel Ranch is very large, and should allow for some in depth analyses of fire effects on lizard populations and community structure. In addition, we plan to examine microgeographic variation in lizard distribution, abundance and community composition. The future of research on ridge-nosed rattlesnakes in the Peloncillo Mountains seems in doubt. At present, we can only recommend that ridge-nosed rattlesnake work be discontinued until objectives become clearer based on consultation with the many and diverse stakeholders involved. One potential avenue of research that we feel could provide important data is fire effects modeling on ridge-nosed rattlesnake habitat.

Budget

The requested total budget for the entire project is $410,000 (detailed year-by-year and project-by-project budgets available), which equals $82,000 per year for five years. To date, we have received $175,000 for the first two and a half years. Rather than requesting three more years of funding at approximately $80,000 per year for a total of $240,000, we are requesting approximately $100,000 per year for the next two years (Phases III-IV). In the final year (Phase V), we will request the remaining $35,000 to be used in data analyses, report writing, and manuscript preparation.

Personnel (ERE included)	Hourly Rate	Hours/Week	Total Weeks	Totals
P.I.	27	20	26	14,040
Grad. Assistant (half time)	17	20	52	17,680
Biological Technician	10	40	24	9,600
Biological Technician	10	40	24	9,600
High School Intern	6.5	40	16	4,160
Federal Work-study Student	2	30	52	3,120
Federal Work-study Student	2	30	52	3,120
			Subtotal	*61,320*
Travel				
Per Diem (180 x 4 x $29.50/day)				21,240
Lodging (210 days @ $25/day)				5,250
Mileage (16,000 miles @ $0.345/mile)				5,520
			Subtotal	*32,010*
Equipment	Units	Price/Unit		
Radiotelemeters (New)	20	300		6,000
Radiotelemeters (Refurbished)	20	115		2,300
Receivers	2	700		1,400
Antennae	2	225		450
			Subtotal	*10,150*
Surgery Supplies				
Isoflurane	2 bottles	50		100
Alcohol Swabs, Sterile Gauze	5 box (100)	5		25
Scalpel Blades	1 box (50)	30		30
Blood Collection Kit	2 boxes (50)	100		200
Suture	4 boxes (72)	75		300
Vacutainers	1 box (100)	40		40
Povidone/Betadine, Isopropyl Alcohol	11 bottle	10		110
Sterile Gloves	3 boxes (75)	25		75
			Subtotal	*800*
Processing Equipment				
Whirl-pacs	2 boxes (500)	37.5		75
PIT-tags	1000	4.25		4,250
			Subtotal	*4,325*
Misc. Equipment/Supplies				
rebar, wire for trap repair				200
generator				900
used 4-wheeler				1,500
photocopies, batteries, notebooks, etc.				550
PDAs				200
			Subtotal	*3,350*
			Grand Total	**111,955**

Effects of Fire and Grazing on Malpai Borderlands Herpetofauna: A Multifaceted Research Program

PHASE III ANNUAL REPORT – 2005
PHASE IV WORK PLAN – 2006

Submitted By:

Matt Goode, Principal Investigator
School of Natural Resources
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

December 5, 2005

Introduction

The purpose of this agreement is to conduct long-term research on the effects of fire and grazing on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Mexico. We are investigating single species, population, and community level effects of fire and grazing on a variety of herpetofauna at sites in the Peloncillos Mountains, the Sierra San Luis, and the Animas Valley. It is important to understand that our research program is adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency and the Malpai Borderlands Group, funding availability, weather conditions, changes in fire and grazing plans, and the realities of field work in a highly variable environment.

Our research program consists of three separate studies phased in over six years. Phase I was completed in 2002-2003, and Phase II was completed in 2004. This past field season, we completed the field portion of Phase III and we are now compiling and analyzing data, writing progress reports, preparing a presentation for the Malpai Borderlands Group annual science meeting in January 2006, and planning for next field season. We will begin the 2006 field season in March and finish in October. Current funds will end and we will receive the next round of funding in January 2006. In this report we provide a brief recap of Phases I and II, a project-by-project account of Phase III accomplishments for 2005, and our work plan for 2006 (Phase IV).

Phase I

Phase I of this research program began in September of 2002 and was completed at the end of the 2003 field season. Our objectives in the initial phase were to (1) conduct snake and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna. We were able to meet all three objectives except Objective 2, because K. Setser and colleagues were unable to obtain USFWS and Mexican scientific collecting and research permits.

Phase II

Our objectives in Phase II were to (1) begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch; (2) initiate radiotelemetry studies of snakes at McKinney Flats; and (3) conduct limited surveys for ridge-nosed rattlesnakes in previously burned areas in the Peloncillo Mountains. However, because we did not receive funding until mid-August, and because our USFWS Endangered Species Permit was not approved until late August, we were forced to delay or postpone field-related aspects of Phase II objectives. However, this was not a significant problem, because we found that additional consultation and planning was required before moving forward with research related to fire and ridge-nosed rattlesnakes in the Peloncillo Mountains given the complexity of issues involved. In addition, there was no urgency to conduct pre-treatment surveys at Cascabel Ranch due to the lack of precipitation events required to "calibrate" the watersheds for research related to effects of fire on hydrological function. And finally, it was decided by the ad hoc snake advisory team that radiotelemetry research on ridge-nosed rattlesnakes was not an immediate priority, meaning that our objectives changed.

After a great deal of discussion and planning, we were finally able to conduct Phase II field work in the spring of 2004. We began all three projects, which meant that several people were working in the field at different sites. It was a very busy and productive field season.

Phase III

In this section, we provide a project-by-project account of our objectives and results for 2005 and our plans for 2006.

Effects of Fire on New Mexican Ridge-nosed Rattlesnakes

In this project, we are examining the effects of fire on various aspects of New Mexican ridge-nosed rattlesnake (*Crotalus willardi obscurus*) ecology. These rattlesnakes are threatened under the Endangered Species Act, so the need to obtain information about the species that can be used to develop effective management strategies is a high priority. Furthermore, the species has been at the center of a lively debate over how to restore fire to the Peloncillos without harming the snake or its habitat. Much of this debate has been based on a paucity of ecological data, because rattlesnakes are extremely difficult to find, precluding any meaningful research on the species. Because it took greater than 30 person-days to find a ridge-nosed rattlesnake (A. Holycross, personal communication), we decided to determine if we could obtain more snakes using funnel trap and drift fence arrays. The overall goal was to find snakes in sufficient numbers to conduct meaningful research (e.g., radiotelemetry and habitat analyses). In addition, a more reliable capture method would enable us to determine if snakes were present in canyons where they have not been previously documented, and may even lead to a method for monitoring effects of fire on snakes. Ultimately, results would inform the Peloncillos Programmatic Fire Management Plan by identifying occupied habitat, leading to a more judicious prescribed fire regime.

Unfortunately, extensive trapping efforts in 2004 produced only two ridge-nosed rattlesnakes. In addition, extensive foot searches, including a substantial volunteer effort from Sky Island Alliance, produced only one additional snake. In 2005, we continued with a more modest trapping effort, which failed to produce a single snake, and limited foot searches produced only one snake. To date, total snake captures stand at four individuals, a poor return on our investment by any measure. Therefore, we decided to discontinue trapping after the 2005 field season. In fact, we had already substantially reduced trapping efforts, only opening traps a total of 30 days while conducting lizard surveys at nearby Cascabel Ranch.

We decided to refocus our efforts in 2005 by studying ridge-nosed rattlesnakes in the Sierra San Luis in northern Mexico. Initially, we planned to conduct research in the Sierra San Luis in 2002, but Matt Goode stopped his involvement in the Sierra San Luis work in October 2002, at which time Gary Belovsky at the University of Notre Dame became the principal investigator, and Kirk Setser remained the graduate student in charge of fieldwork. To date, K. Setster and colleagues have collected two years of data at three sites in the Sierra San Luis, including Cañon San Luis and Study Canyon in the northern part of the range, and 30 km south in the Cajon Bonito at Rancho Pan Duro. In 2003, K. Setser determined that ridge-nosed rattlesnakes were more active in late summer and early fall, causing him to focus his efforts into a six-week period from early September to mid-October. Detailed results of K. Setser's work can be found in his 2003 and 2004 annual reports to the Forest Service. Because K. Setser was so successful in capturing ridge-nosed rattlesnakes in the Sierra San Luis, even in areas that previously burned, we decided to continue work in 2005. We planned to place

an emphasis on habitat selection in burned and unburned areas in order to maximize the chance that data gathered in the Sierra San Luis could inform the problematic circumstances associated with snakes and fire in the Peloncillo Mountains. In addition, it was agreed that learning more about the snake in the Sierra San Luis, where it occupies lower elevation habitats, which are more similar to those available in the Peloncillos, would prove useful in formulating future management decisions and research directions. And finally, we met with Valere Austin and Ruben Ruiz and decided to work with them to produce an educational video featuring Mexican students and biologists conducting field research. It was agreed that Ruben Ruiz would record and produce a video to be paid for by Valere Austin and shown to school children from Agua Prieta. We were very excited about getting involved in community conservation in Mexico and felt like this would be a great addition to the project.

Finally, Carl Edminster and Forest Service personnel from the Douglas Ranger District suggested that we add the objective of assessing in more detail the extent to which the Baker II Burn affected potential snake habitat. Gary Helbing and Peter Warren (TNC) had flown over the burn in a helicopter and mapped fire intensity for the entire burn. However, CNF personnel felt that it was important to more precisely quantify fire intensity within potential snake habitat.

Specific objectives for the New Mexico ridge-nosed rattlesnake project in 2005 included:

- Continue to assess the efficacy of funnel traps in the Peloncillo Mountains
- Continue foot searches in the Peloncillo Mountains to determine new localities
- Continue studying ridge-nosed rattlesnakes in the Sierra San Luis (truncated field season)
- Conduct research on habitat selection by snakes in burned and unburned areas in the Sierra San Luis
- Produce educational video of research in conjunction with the Austin and Ruiz families
- More precisely quantify fire intensity within potential snake habitat affected by Baker II burn

We spent 144 person-hours searching for ridge-nose rattlesnakes in 2005. Our efforts were limited to four six-day periods spread out between June and September. We also operated funnel traps during these four periods for a total of 2,101 trap-nights. We did manage to capture one ridge-nosed rattlesnake during a foot search, and an additional 21 snakes comprising 8 species. Again, we conclude that ridge-nosed rattlesnake are indeed very hard to come by in the Peloncillo Mountains, confirming previous findings.

We were unable to meet the last four objectives listed above, because K. Setser, who was in charge of field work, was dismissed from the project in August of 2005 on the day that we were supposed to begin the field season. We are planning on resuming our work in the Sierra San Luis in 2006 and we will meet the objectives at that time. The last objective, to quantify fire intensity in potential habitat polygons that burned during the Baker II fire was abandoned due to funding cuts, and because discussions with Carl Edminster resulted in this objective becoming a lower priority.

Effects of Fire and Grazing on Grassland Herpetofauna at McKinney Flats

We are taking advantage of ongoing, landscape-scale research conducted by Charles Curtin and other investigators at McKinney Flats on the eastern division of the Diamond A Ranch. Our original goal was to assess the effects of fire and grazing on prairie rattlesnakes (*Crotalus viridis*) using radiotelemetry. Therefore, we set up drift fences and funnel trap arrays to capture snakes for implantation. However, it was immediately apparent that we could capture large numbers of individual snakes of numerous species. For the past two years, we have been gathering a wealth of

data on the snake species assemblage present at McKinney Flats. Currently, we have 376 traps placed in each of four experimental pastures, and we have captured nearly 1200 individual snakes belonging to 20 species. This is an unprecedented dataset and has become a primary focus of our work at McKinney Flats. In addition, we are continuing to radiotrack prairie rattlesnakes and now have data on approximately 20 individuals spanning a two-year period. In addition, Kevin Baker, the graduate student in charge of fieldwork, and Cecil Schwalbe, Kevin's graduate advisor, have taken over lizard sampling for C. Curtin at McKinney Flats. Unfortunately, plans for a prescribed fire in Spring 2005 were cancelled, because ironically, conditions were too wet. Therefore, follow-up grazing was also not initiated. We are now planning to continue gathering data at McKinney Flats, hoping that fire and grazing will finally take place in 2006. We are also discussing ways to adapt snake sampling strategies to the existing experiment being carried out by C. Curtin and colleagues, which was not designed with snakes in mind and is therefore at the improper scale to take full advantage of impending land management practices.

Specific objectives for McKinney Flats project in 2005 included:

- Continue radiotelemetry study of prairie rattlesnakes at McKinney Flats
- Continue to gather data on snake species assemblage
- Determine trophic interactions of snakes by examining diet based on fecal analyses
- Characterize and quantify vegetation and small mammal burrows

In 2004 we captured 622 individual snakes comprising 18 species with total captures (including recaptures) equaling 1034 snakes. This past year, we captured 597 individual snakes; 543 new individuals and 54 individuals initially captured last year. In 2005, our total captures was 1122.

We divided our captures into five areas; NE, NW, SE, and SW pastures of McKinney Flats, and Culberson. The Culberson area was comprised of the region east of McKinney Flats and west of the wash behind the Culberson bunkhouse. Because we did not include this area in our arrays, all snakes we captured in this area were caught while driving the roads or by other incidental means. We captured 528 of the 543 new individuals (97%) in the four pastures on McKinney Flats. We captured the highest number of new individuals (n = 183, 38 % of pastures total) comprising 15 species in the northeast pasture. We captured 145 new snakes from 14 species in the southwest pasture (27%); 98 (15 species) in northwest pasture (18%), and 102 (12 species) in southeast pasture (19%).

We finished the season with 17 telemetered *C. viridis* - 9 females and 8 males. We only had telemetered snakes in northeast and southeast pastures, a function of their distribution. We captured 66 total new *C. viridis* in the four pastures, 39 in NE (59%), 20 in SE (30%), 5 in NW (8%), and 1 in SW (1.5%). Twelve of the telemetered snakes were in the northeast pasture (6 males and 6 females). Overall, males had a larger homerange MCP, larger 95% Fixed Kernel Home Range (FKHR), longer mean, maximum, and total distance moved. The mean 50% FKHR core activity area for males (24.14 ha) was significantly larger than the female mean 50% Fixed Kernel area (17.25 ha) ($P = .03$). These results are based on calculations done with males and females radio-tracked for two consecutive years.

Table 1. Number of individuals captures on McKinney Flats in 2005. 'New Individuals Trapped in 2005' includes only snakes trapped in 2005 that were not captured in 2004. 'Total Individuals Trapped 2005' includes snakes from previous column and individuals originally captured in 2004 that were re-captured in 2005. 'Total New Individuals Captured in 2005' includes all new individuals captured by various methods (trapping, tracking, road cruising, etc.)

Species	New Individuals Trapped in 2005	Total Individuals Trapped in 2005	Total New Individuals Captured in 2005
Masticophis flagellum	107	133	109
Salvadora hexalepis	65	78	76
Pituophis catenifer	62	106	78
Thamnophis cyrtopsis	40	40	44
Crotalus viridis	30	36	66
Heterodon nasicus	28	50	28
Crotalus atrox	24	32	35
Masticophis bilineatus	20	20	22
Salvadora grahamiae	19	20	19
Lampropeltis getula	12	23	13
Rhincielus lecontei	12	20	12
Hypsiglena torquata	10	12	11
Arizona elegans	6	9	7
Sonora semiannulata	6	6	9
Tantilla nigriceps	2	2	2
Thamnophis marcianus	2	2	4
Trimorphodon biscutatus	2	2	2
Gyalopion canum	6	6	6
Crotalus lepidus	0	0	0
Tantilla hobartsmithi	0	0	0
Total	**453**	**597**	**543**

Table 2. Crotalus virids 95% and 50% fixed kernal home ranges for female and male snakes tracked in both 2004 and 2005.

Snake ID	Gender	95% kernel (ha)	50% kernel (ha)
9	F	37.20	8.70
17	F	23.96	2.20
27	F	114.22	10.85
7	M	219.61	33.13
8	M	52.16	6.21
10	M	273.75	23.91
11	M	258.95	33.29

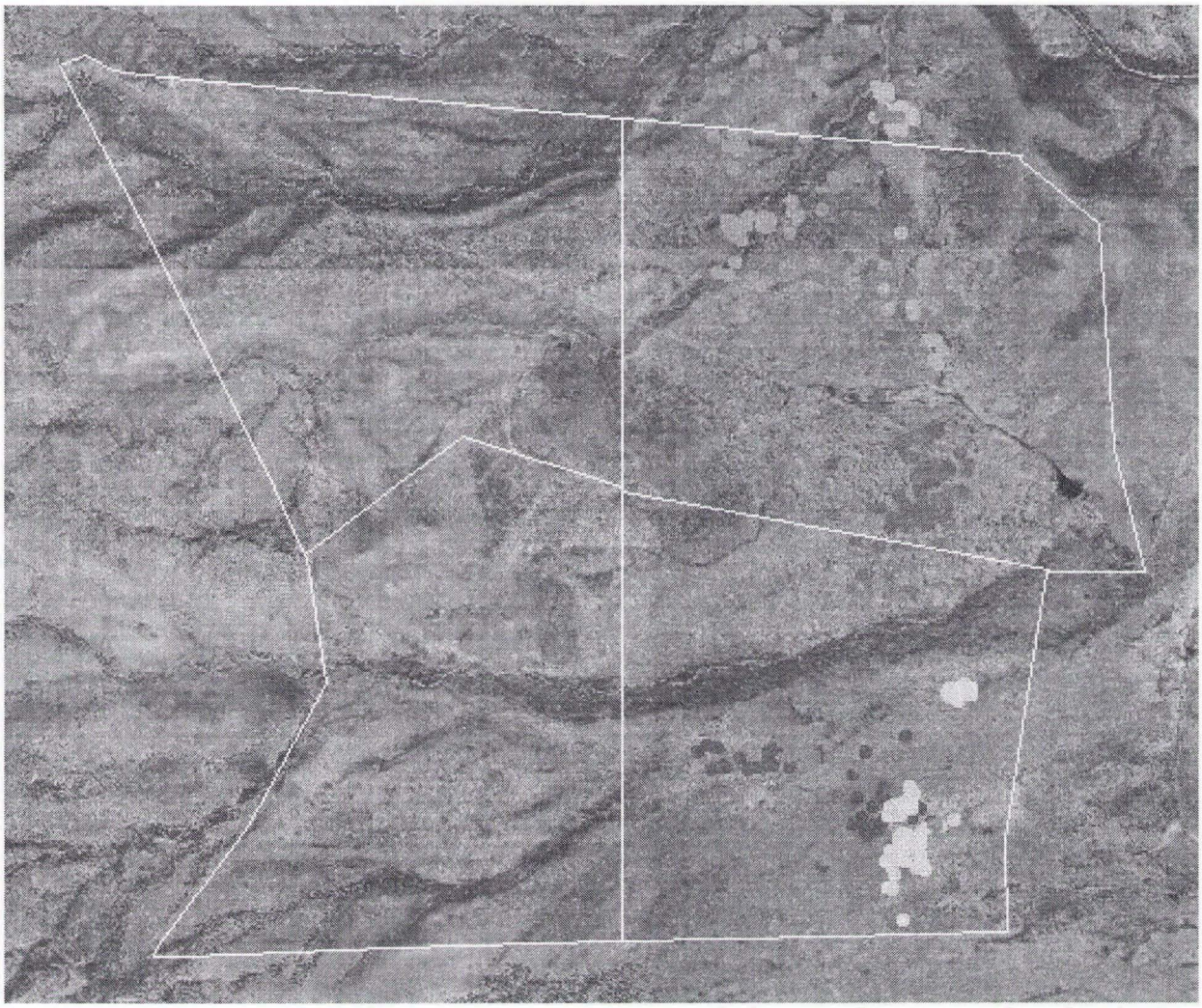


Figure 1. Overview of McKinney Flats showing locations of telemetered prairie rattlesnakes (various colored dots; N = 16) and the four pastures. We currently have one telemetered snake in Mexico and one in the pasture north of McKinney Flats.

Although we were surprised by the large number of snakes we captured last year, we were even more surprised to find that this year we actually captured more new individuals, and the number of snakes from 2004 that we recaptured in 2005 was much lower than we suspected. We want to re-emphasize that the huge number of snakes we have captured represents an unprecedented data set for a snake assemblage. We plan to continue to obtain for as long as possible in order to examine annual and seasonal variation in snake abundance, demography, diet, growth and reproduction. In addition, our data will add to our knowledge of how fire and grazing affect ecological processes in Chihuahuan Desert grasslands, including trophic interactions and response to environmental change, as revealed by combining our data with data already gathered on site.

Charles Curtin and colleagues planned to burn McKinney Flats in late spring or early summer of 2005, but ironically, conditions were too wet to carry a fire. Because they didn't burn in 2005, the pastures were also not restocked with cattle. Although this allowed us to obtain additional baseline data, we were unable to examine effects of fire and grazing on prairie rattlesnakes or on the snake assemblage present. A burn is again planned for the spring or late summer of 2006, which if it occurs, will be the first significant burn of the area since 1998. We will continue to track our telemetered animals and to run our trap arrays. This past year, we also completed distance sampling of rodent burrows and kangaroo rat mounds (refugia for snakes), and we have conducted extensive habitat analyses, including using existing data on vegetation and soils, which will allow us to examine environmental and biological factors that might influence distribution, growth, reproduction and diet of the snakes at McKinney Flats.

Effects of Fire on Herpetofauna in Replicated Watersheds at Cascabel Ranch

In this project, we are taking advantage of a long-term study at Cascabel Ranch, on the eastern edge of the Peloncillo Mountains, where Jerry Gottfried (US Forest Service) and associates are conducting research on the effects of fire on hydrological regimes. At Cascabel Ranch, several watersheds have been instrumented and will be calibrated when sufficient monsoon rains occur. We plan to use a before-after-control-impact (BACI) study design with paired sampling to analyze data obtained from herpetofauna surveys of these watersheds. We have now obtained two years of baseline data on species composition and relative diversity of amphibians and reptiles in several watersheds prior to burning. Next year, we are poised to collect post-treatment data if the watersheds are burned as planned. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna. In addition, we have an excellent opportunity to examine associations of a variety of environmental parameters with microgeographic variation in lizard assemblages.

Specific objectives of the Cascabel Ranch project included:

- Survey watersheds (12 watersheds, 3 plots each) twice each in spring and twice each in summer
- Determine species diversity, evenness, relative abundance and demography of herpetofauna
- Obtain microhabitat data on common lizards species
- Examine relationship of lizards to their environment (e.g., vegetation, soil, temperature, rainfall)
- Compare pre- and post-burn data in an experimental framework

We completed spring (pre-monsoon) and summer (monsoon) surveys at Cascabel Ranch. We randomly located three one-hectare plots in each of 12 watersheds. We surveyed all three plots during

the morning hours during peak activity of common diurnal lizards. Two to three people surveyed each morning. We surveyed each plot for one hour for a total of three hours per morning. We surveyed all 12 watersheds two times each during pre-monsoon and monsoon sampling periods. We decided to drop one 6-day sampling period from both pre- and post-monsoon seasons to save money, and because we have obtained such a large data set that statistical analyses will not be a problem due to small sample size.

We spent a total of 48 person-days conducting surveys in the watersheds at Cascabel Ranch. Our efforts have resulted in a large data set on several common diurnal lizards species that use the arroyos. In total, we observed 2,219 lizards comprising 10 species, 13 snakes comprising 4 species, 3 turtles comprising 1 species, and no toads. During the pre-monsoon season, we observed 1470 lizards compared to 749 during the monsoon season. The substantial decrease in relative abundance is likely due to the relative paucity of whiptail lizards during the summer rainy period when temperatures are somewhat lower. Also, an increase in cloudy and rainy days tends to dampen lizard activity, although we did not survey on days with excessive cloud cover or during rain.

We are concentrating our analyses on the lizard community at Cascabel Ranch. The most common lizard species in 2005 was the Sonoran spotted whiptail (n = 901), followed by the tree lizard (n = 720). This coming year, we will continue to gather data on the lizard community at Cascabel Ranch. This will enable us to compare before and after data on the effects of fire on relative abundance, species diversity, evenness, and population structure of lizards observed. By collecting data over multiple years, we will have a better idea of the effects of annual variation on lizard ecology. The existence of a wealth of data on the physical and biotic environment at Cascabel Ranch that has been mostly gathered by Forest Service personnel, will allow us to examine underlying causes leading to the relationship between lizard ecology and fire.

Conclusions

We had a very successful field season in 2005, and we have conducted preliminary analyses of our data. We feel strongly that the McKinney Flats Project and the Cascabel Ranch Project have been extremely valuable. We have obtained an unprecedented data set on the snake community at McKinney Flats. In addition, we have been very successful in obtaining and monitoring prairie rattlesnakes, and we are excited about the prospects of examining the effects of fire on rattlesnakes in spring 2006, and of grazing later in the year. Our data set on lizards at Cascabel Ranch is very large, and should allow for some in depth analyses of fire effects on lizard populations and community structure. There is a good chance that they will begin burning on the watersheds in 2006, so we can start to collect post-burn data. In addition, we plan to examine microgeographic variation in lizard distribution, abundance and community composition. The future of research on ridge-nosed rattlesnakes in the Peloncillo Mountains seems in doubt. At present, we can only recommend that ridge-nosed rattlesnake work be discontinued until objectives become clearer based on consultation with the many and diverse stakeholders involved. One potential avenue of research that we feel could provide important data is fire effects modeling on ridge-nosed rattlesnake habitat. Although our plan was to continue work in the Sierra San Luis, the loss of Kirk Setser to the project at the last possible moment meant that we had to cancel the field season. We are now gearing up for work in the Sierra San Luis in August-October of 2006.

Budget

This year we are requesting $82,350, although Carl Edminster has asked us to put in our requests in increments of roughly $20,000. Therefore, the first amendment for 2006 totals $20,458. We will request the remainder of the total annual funding in three additional increments early March, early June, and early September.

Total Budget for FY 2006

Personnel (ERE included)	Hourly Rate	Hours/Week	Total Weeks	Total
P.I.	27.5	16	52	22,880
Grad. Assistant (summer)	15	40	8	4,800
Biological Technician	11	40	36	15,840
Biological Technician	11	40	20	8,800
Biological Technician	11	40	16	7,040
Biological Technician	11	40	16	7,040
Federal Work-study Student	2	20	52	2,080
Federal Work-study Student	2	20	52	2,080
Federal Work-study Student	2	20	52	2,080
			Total	72,640
Travel				
Mileage (10,000 miles @ $0.385/mile)				3,850
			Total	3,850
Equipment	Units	Price/Unit		
Radiotelemeters (Refurbished)	24	140		3,360
Surgery Supplies				1,000
PIT Tags	1000	4		4,000
Miscellaneous Supplies (batteries, etc.)				500
			Total	8,860
			Total	85,350

Effects of Fire and Grazing on Malpai Borderlands Herpetofauna: A Multifaceted Research Program

ANNUAL REPORT – 2006
WORK PLAN – 2007

Submitted By:

Matt Goode, Principal Investigator
School of Natural Resources
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

December 15, 2006

Introduction

The purpose of this agreement is to conduct long-term research on the effects of fire and grazing on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Mexico. We are investigating single species, population, and community level effects of fire and grazing on a variety of herpetofauna at sites in the Peloncillos Mountains, the Sierra San Luis, and the Animas Valley. It is important to understand that our research program is adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency and the Malpai Borderlands Group, funding availability, weather conditions, changes in fire and grazing plans, and the realities of field work in a highly variable environment. Our research program consists of three separate studies that began in 2002. This report covers the 2006 field season 2007 work plan.

2002-2005 Activities

We began the project in September of 2002. Our objectives in the initial phase were to: (1) conduct snake and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna. We were able to meet all three objectives except Objective 2, because Kirk Setser (who left the University of Arizona and continued to conduct research at Notre Dame University) and colleagues were unable to obtain USFWS and Mexican scientific collecting and research permits.

Our objectives for the 2003 field season were to: (1) begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch; (2) initiate radiotelemetry studies of snakes at McKinney Flats; and (3) conduct limited surveys for ridge-nosed rattlesnakes in previously burned areas in the Peloncillo Mountains. However, because we did not receive funding until mid-August, and because our USFWS Endangered Species Permit was not approved until late August, we were forced to delay or postpone field-related aspects of our objectives. However, this was not a significant problem, because we found that additional consultation and planning was required before moving forward with research related to fire and ridge-nosed rattlesnakes in the Peloncillo Mountains given the complexity of issues involved. In addition, there was no urgency to conduct pre-treatment surveys at Cascabel Ranch due to the lack of precipitation events required to "calibrate" the watersheds for research related to effects of fire on hydrological function. And finally, it was decided by the ad hoc snake advisory team that radiotelemetry research on ridge-nosed rattlesnakes was not an immediate priority, meaning that our objectives changed.

After a great deal of discussion and planning, we were finally able to begin fieldwork in the spring of 2004. We began all three projects, which meant that several people were working in the field at different sites. We installed trap arrays in the Peloncillos, which proved to be ineffective at capturing ridge-nosed rattlesnakes. We also spent a great deal of time conducting foot searches for snakes, which only produced one individual. At Cascabel Ranch, we conducted pre- and post-monsoon lizard surveys that produced over 2000 lizard observations. And finally, we installed approximately 400 funnel traps in the experimental pastures at McKinney Flats, which resulted in over 1000 snake captures comprised of 18 species. We also began radiotelemetry studies of prairie rattlesnakes at McKinney Flats. It was a very busy and productive field season, and we were able to meet, and in some cases, surpass our objectives. In addition, we obtained information that would

allow us to adapt future goals and objectives to the needs of interested stakeholders, and continuing budget constraints.

In 2005, our objectives for ridge-nosed rattlesnake research were to: 1) continue to assess the efficacy of funnel traps in the Peloncillo Mountains; 2) continue foot searches in the Peloncillo Mountains to determine new localities; 3) continue studying ridge-nosed rattlesnakes in the Sierra San Luis, following the work conducted by K. Setser and colleagues in 2003-2004; 4) conduct research on habitat selection by snakes in burned and unburned areas in the Sierra San Luis; 5) produce an educational video of research in conjunction with the Austin and Ruiz families; and 6) more precisely quantify fire intensity within potential snake habitat affected by Baker II burn.

We did manage to capture one ridge-nosed rattlesnake in the Peloncillos during a foot search, but we concluded that ridge-nosed rattlesnake are indeed very rare in the Peloncillo Mountains, and we decided to discontinue trapping there. Unfortunately, we were unable to meet objectives 3-5, because K. Setser, who was in charge of fieldwork, was dismissed from the project in August of 2005 on the day that we were supposed to begin the field season. We are planning on resuming our work in the Sierra San Luis in 2006. The last objective, to quantify fire intensity in potential habitat polygons that burned during the Baker II fire, was abandoned due to funding cuts, and because discussions with Carl Edminster resulted in this objective becoming a lower priority.

Our research at McKinney Flats was very productive; we captured nearly 600 snakes belonging to 20 species. We also tracked 17 prairie rattlesnakes, obtaining valuable baseline data. Unfortunately, plans for a prescribed fire in the spring of 2005 were cancelled, because ironically, conditions were too wet. Therefore, follow-up grazing was also not initiated. We were able to obtain extensive on important variables, such as vegetation, soils, and rodent densities, which will allow us to examine environmental and biological factors that might influence distribution, growth, reproduction and diet of the snakes at McKinney Flats.

And finally, we spent a total of 48 person-days conducting surveys in the watersheds at Cascabel Ranch in 2005. Our efforts have resulted in a large data set (ca., 4500 total lizard observations) on several common diurnal lizards species that use the arroyos. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna. In addition, we have an excellent opportunity to examine associations of a variety of environmental parameters with microgeographic variation in lizard assemblages.

2006 Accomplishments and 2007 Work Plan

We began 2006 by giving two presentations at the Malpai Borderlands Group Science Meeting. M. Goode presented data comparing relative abundance of ridge-nosed rattlesnakes in Study Canyon in the Sierra San Luis before and after a catastrophic wildfire that occurred in 1989. He compared capture data based on search effort from data obtained by Jim Barker before the fire and Kirk Setser after the fire. Caution must be used in interpreting results, because search effort had to be estimated in some cases and can only be used as an index of relative abundance. However, field workers captured one snake every 3.3 days before the fire, and one snake every 3.8 days after the fire. We do not wish to overinterpret these data, but they do suggest that ridge-nosed rattlesnakes can survive a catastrophic wildfire. However, applying this knowledge to snakes in the Peloncillos is fraught with difficulty,

primarily because relative abundance is extremely low there, and it is conceivable that snakes would not be able to withstand its effects the same way a robust population apparently can.

Kevin Baker, graduate student in charge of fieldwork at McKinney Flats, presented his results on prairie rattlesnake ecology. In general, prairie rattlesnakes at McKinney Flats are quite different than their counterparts from more northern populations. For instance, they do not overwinter in large groups, forming a communal hibernaculum, but rather they tend to spend the winter either alone or with one or two other snakes deep inside kangaroo rat mounds. Another apparent difference is the fact that they are able to reproduce annually, in contrast to northern populations where reproduction may only occur every 2-3 years.

After updating interested stakeholders about our research, we prepared for 2006 field season with a great deal of excitement, because we were told that prescribed burns were being planned for both McKinney Flats and the watersheds at Cascabel Ranch. This would give us the opportunity to address our overarching goal of examining the effects of fire with robust pre-treatment datasets. We decided to add another field season tracking prairie rattlesnakes in an effort to determine how the snakes would respond to fire, and subsequent grazing. Unfortunately, the prescribed fire was unsuccessful in changing the landscape in the way we had hoped. The fire burned patchily and most vegetation had to be ignited one clump at a time using drip torches. Within a few weeks of the burn, it was difficult to see any signs that a fire had recently burned. In addition, they decided not to burn at Cascabel Ranch again. We were able to continue to gather baseline data at both sites, which is very valuable even in the absence of post-fire data, because we will be able to publish several papers on various aspects of herpetofaunal community ecology and prairie rattlesnake natural history and ecology. This information will ultimately have application to management of grassland and encinal ecosystems, as we increase our understanding of these poorly known taxa.

We did not conduct any research on ridge-nosed rattlesnakes in the Peloncillo Mountains, nor did we plan to going into the field season. Our objective was to reinitiate research in the Sierra San Luis, focusing on population comparisons in burned and unburned habitats. Unfortunately, we were unable to obtain a Mexican scientific research permit, because our Mexican collaborator (E. Mociño) decided not to assist us in obtaining a permit after already having submitted a request. We are currently working with another Mexican collaborator who has already submitted the permit request, so we can finally continue research in the Sierra San Luis. In addition, we are working with private landowners in Mexico in an effort to involve the local community and Mexican scientists in our research, via collaboration and environmental education.

And finally, we are adding a new component to our research program. We have been conducting long-term research on the ecology and conservation genetics of tiger rattlesnakes in the Tucson basin. Our work is focused on the effects of anthropogenic habitat fragmentation on gene flow in snake populations. This research is of particular interest to the Coronado National Forest, because the city of Tucson is encroaching on the forest boundary along the foothills of the Santa Catalina Mountains. We have been collecting blood samples for genetic analyses on snakes throughout the Santa Catalina Mountains on Forest Service land, with an emphasis on Sabino Canyon. In FY2007, we will begin to use a small portion of our funding to help support this project, which is nearing completion. Approximately $2,500 will go towards paying laboratory personnel to extract and amplify DNA and develop and score microsatellite DNA markers in the laboratory of Dr. Melanie Culver at the University of Arizona, School of Natural Resources. Dr. Culver will donate her time spent training and supervising technicians, which will be federal work-study students, who dramatically reduce costs

and benefit from learning contemporary genetic laboratory techniques. Approximately $2,500 will also go to purchase laboratory supplies, primers, reagents, and plastic consumables. This addition to the project will result in important information that can be used to manage the effects of habitat fragmentation caused by human encroachment on forest boundaries. Also, there will be many opportunities to acknowledge the US Forest Service, Coronado National Forest, and Rocky Mountain Research Station in future publications.

Budget - 2007

We are requesting an initial amount of $15,000 to bridge the gap between the end of the fiscal year on September 30, 2006 and the passing of the federal budget in early 2007. We will request the remainder of the total annual funding in early 2007 after the federal budget has passed. We have only included the total budget in this report; we submitted a modification to the agreement (see official Forest Service documents) for the initial $15,000. In order to continue our research at a significantly lower level of funding, we are forced to reduce our effort at McKinney Flats. We decided that the research at Cascabel Ranch and the ridge-nosed rattlesnake research in the Sierra San Luis are most important at this time. We have added a limited amount of funding to go towards an additional project on conservation genetics of snakes in the Tucson area, including the Coronado National Forest in the Santa Catalina Mountains. Although the research at McKinney Flats has been very successful, the lack of successful prescribed fires and renewed grazing force us to reduce our efforts there. We feel that we will be able to continue the project productively with reduced sampling effort, amounting to approximately 10 days per month from May-October.

Total Budget for FY 2007

Personnel (ERE included)	Hourly Rate	Hours/Week	Total Weeks	Total
P.I.	29	16	52	24,128
Grad. Assistant (summer)	15	40	8	4,800
Wildlife Biologist	15	40	12	7,200
Biological Technician	11	40	20	8,800
Biological Technician	11	40	20	8,800
Federal Work-study Student	2	20	52	2,080
Federal Work-study Student	2	20	52	2,080
			Subtotal	59,968
Travel				
Mileage (10,000 miles @ $0.385/mile)				3,850
			Subtotal	3,850
Equipment	Units	Price/Unit		
Radiotelemeters (Refurbished)	24	140		3,360
Genetic Lab Supplies				1,500
PIT Tags	1000	4		4,000
Miscellaneous Supplies (batteries, etc.)				
			Subtotal	8,860
			Total	**68,828**

Budget For First Quarter FY 2006

Personnel	Hourly Rate	Hours/Week	Total Weeks	Funds Requested
P.I.	27.5	16	13	5,720
Grad. Assistant (summer)	15	40	2	1,200
Biological Technician	10	40	9	3,600
Biological Technician	10	40	5	2,000
Biological Technician	10	40	4	1,600
Biological Technician	10	40	4	1,600
Federal Work-study Student	2	20	13	520
Federal Work-study Student	2	20	13	520
Federal Work-study Student	2	20	13	520
				17,280
Travel	Miles	Rate		
Mileage	2,500	0.385		963
				963
Equipment	Units	Price/Unit		
Radiotelemeters (Refurbished)	6	140		840
Surgery Supplies				250
PIT Tags	250	4		1,000
Miscellaneous Supplies (batteries, etc.)				125
				2215
			Grand Total	**20,458**

Effects of Fire and Grazing on Malpai Borderlands Herpetofauna: A Multifaceted Research Program

ANNUAL REPORT – 2007

Submitted By:

Matt Goode, Principal Investigator
School of Natural Resources
University of Arizona

Submitted To:

Carl Edminster, Program Manager
Rocky Mountain Research Station
United States Forest Service

January 31, 2007

Introduction

The purpose of this agreement is to conduct long-term research on the effects of fire and grazing on herpetofauna in the Malpai Borderlands region of southeastern Arizona, southwestern New Mexico and northern Mexico. We are investigating single species, population, and community level effects of fire and grazing on a variety of herpetofauna at sites in the Peloncillos Mountains, the Sierra San Luis, and the Animas Valley. It is important to understand that our research program is adaptive in nature and that our objectives have been changing from year to year depending on needs of the funding agency and the Malpai Borderlands Group, funding availability, weather conditions, changes in fire and grazing plans, and the realities of field work in a highly variable environment. Our research program consists of four separate studies that began in 2002. This report covers the 2007 field season.

2002-2006 Activities

We began the project in September of 2002. Our objectives in the initial phase were to: (1) conduct snake and habitat surveys in historical burn sites in the Sierra San Luis in Mexico; (2) initiate radiotelemetry studies of snakes in burned and unburned sites in the Sierra San Luis; (3) visit and assess experimental plots at Cascabel Ranch and McKinney Flats; and (4) develop a long term, multiple project research program designed to assess effects of fire on herpetofauna. We were able to meet all three objectives except Objective 2, because Kirk Setser (who left the University of Arizona and continued to conduct research at Notre Dame University) and colleagues were unable to obtain USFWS and Mexican scientific collecting and research permits.

Our objectives for the 2003 field season were to: (1) begin gathering pre-fire baseline data on the herpetofauna community at Cascabel Ranch; (2) initiate radiotelemetry studies of snakes at McKinney Flats; and (3) conduct limited surveys for ridge-nosed rattlesnakes in previously burned areas in the Peloncillo Mountains. However, because we did not receive funding until mid-August, and because our USFWS Endangered Species Permit was not approved until late August, we were forced to delay or postpone field-related aspects of our objectives. However, this was not a significant problem, because we found that additional consultation and planning was required before moving forward with research related to fire and ridge-nosed rattlesnakes in the Peloncillo Mountains given the complexity of issues involved. In addition, there was no urgency to conduct pre-treatment surveys at Cascabel Ranch due to the lack of precipitation events required to "calibrate" the watersheds for research related to effects of fire on hydrological function. And finally, it was decided by the ad hoc snake advisory team that radiotelemetry research on ridge-nosed rattlesnakes was not an immediate priority, meaning that our objectives changed.

After a great deal of discussion and planning, we were finally able to begin fieldwork in the spring of 2004. We began all three projects, which meant that several people were working in the field at different sites. We installed trap arrays in the Peloncillos, which proved to be ineffective at capturing ridge-nosed rattlesnakes. We also spent a great deal of time conducting foot searches for snakes, which only produced one individual. At Cascabel Ranch, we conducted pre- and post-monsoon lizard surveys that produced over 2000 lizard observations. And finally, we installed approximately 400 funnel traps in the experimental pastures at McKinney Flats, which resulted in over 1000 snake captures comprised of 18 species. We also began radiotelemetry studies of prairie rattlesnakes at McKinney Flats. It was a very busy and productive field season, and we were able to meet, and in some cases, surpass our objectives. In addition, we obtained information that would

allow us to adapt future goals and objectives to the needs of interested stakeholders, and continuing budget constraints.

In 2005, our objectives for ridge-nosed rattlesnake research were to: 1) continue to assess the efficacy of funnel traps in the Peloncillo Mountains; 2) continue foot searches in the Peloncillo Mountains to determine new localities; 3) continue studying ridge-nosed rattlesnakes in the Sierra San Luis, following the work conducted by K. Setser and colleagues in 2003-2004; 4) conduct research on habitat selection by snakes in burned and unburned areas in the Sierra San Luis; 5) produce an educational video of research in conjunction with the Austin and Ruiz families; and 6) more precisely quantify fire intensity within potential snake habitat affected by Baker II burn.

We did manage to capture one ridge-nosed rattlesnake in the Peloncillos during a foot search, but we concluded that ridge-nosed rattlesnake are indeed very rare in the Peloncillo Mountains, and we decided to discontinue trapping there. Unfortunately, we were unable to meet objectives 3-5, because K. Setser, who was in charge of fieldwork, was dismissed from the project in August of 2005 on the day that we were supposed to begin the field season. We are planning on resuming our work in the Sierra San Luis in 2006. The last objective, to quantify fire intensity in potential habitat polygons that burned during the Baker II fire, was abandoned due to funding cuts, and because discussions with Carl Edminster resulted in this objective becoming a lower priority.

Our research at McKinney Flats was very productive; we captured nearly 600 snakes belonging to 20 species. We also tracked 17 prairie rattlesnakes, obtaining valuable baseline data. Unfortunately, plans for a prescribed fire in the spring of 2005 were cancelled, because ironically, conditions were too wet. Therefore, follow-up grazing was also not initiated. We were able to obtain extensive on important variables, such as vegetation, soils, and rodent densities, which will allow us to examine environmental and biological factors that might influence distribution, growth, reproduction and diet of the snakes at McKinney Flats.

And finally, we spent a total of 48 person-days conducting surveys in the watersheds at Cascabel Ranch in 2005. Our efforts have resulted in a large data set (ca., 4500 total lizard observations) on several common diurnal lizards species that use the arroyos. This project is particularly attractive because it is experimental and involves several replicates of both treatment and control sites. This type of study is desirable for teasing out potential effects of fire, but is rarely done at this spatial scale, especially with herpetofauna. In addition, we have an excellent opportunity to examine associations of a variety of environmental parameters with microgeographic variation in lizard assemblages.

We began 2006 by giving two presentations at the Malpai Borderlands Group Science Meeting. M. Goode presented data comparing relative abundance of ridge-nosed rattlesnakes in Study Canyon in the Sierra San Luis before and after a catastrophic wildfire that occurred in 1989. He compared capture data based on search effort from data obtained by Jim Barker before the fire and Kirk Setser after the fire. Caution must be used in interpreting results, because search effort had to be estimated in some cases and can only be used as an index of relative abundance. However, field workers captured one snake every 3.3 days before the fire, and one snake every 3.8 days after the fire. We do not wish to overinterpret these data, but they do suggest that ridge-nosed rattlesnakes can survive a catastrophic wildfire. However, applying this knowledge to snakes in the Peloncillos is fraught with difficulty, primarily because relative abundance is extremely low there, and it is conceivable that snakes would not be able to withstand its effects the same way a robust population apparently can.

Kevin Baker, graduate student in charge of fieldwork at McKinney Flats, presented his results on prairie rattlesnake ecology. In general, prairie rattlesnakes at McKinney Flats are quite different than their counterparts from more northern populations. For instance, they do not overwinter in large groups, forming a communal hibernaculum, but rather they tend to spend the winter either alone or with one or two other snakes deep inside kangaroo rat mounds. Another apparent difference is the fact that they are able to reproduce annually, in contrast to northern populations where reproduction may only occur every 2-3 years.

2007 Accomplishments

Fire Effects Research in the Animas Mountains

After discussing our research with interested stakeholders at the annual MBG science meeting in January, we decided to shift our focus in 2007 yet again. Due to the Adobe Fire in the Animas Mountains, we were presented with an opportunity to obtain post-fire data on ridge-nosed rattlesnakes, because the fire encompassed a large portion of the area where research on the snake has been going on for several years. We worked with Charlie Painter of the New Mexico Department of Game and Fish to conduct searches for ridge-nosed rattlesnakes in burned and unburned portions of Indian Creek Canyon. In addition, we established time-area constrained search plots and trapping transects in burned, partially burned and unburned portions of the canyon to enable future sampling of lizards and small mammals (known prey of ridge-nosed rattlesnakes). We captured a total of 42 snakes, including 14 ridge-nosed rattlesnakes (only one of which was a recapture from before the fire and eight were captured in heavily burned areas). We observed 209 lizards while surveying 9 plots twice each. We also captured over 400 small mammals in nearly equal numbers between burned and unburned areas. Although the fire was extremely intense, oak trees have resprouted in large numbers and annual plants have responded as well, providing ample cover for small mammals. In 2008, we plan to continue to conduct snake, lizard and small mammal surveys. We are also planning to submit a grant proposal to the New Mexico Department of Game and Fish to increase our sampling effort, and add bird, insect and plant components in an effort to document post-fire changes in the ecosystem.

Snake Community Ecology at McKinney Flats

In 2007, we completed our fourth year of trapping snakes at McKinney Flats. We did not conduct telemetry on prairie rattlesnakes, because that study ended in 2006. However, the prairie rattlesnake research formed the basis of Kevin Baker's MS degree, which he will receive from the University of Arizona in May 2008. In addition, we helped remove hundreds of pitfall traps that had been used to sample lizards at McKinney Flats for the past 10 years. We captured a total of 350 individual snakes of 15 species in 2007, bringing the four-year total to 3,156 captures, 1757 of which were new captures and 1399 of which were recaptures. Although we will continue our work at McKinney Flats, we will no longer be requesting funding from the Forest Service, as the project is no longer considered a priority now that funding has been reduced. However, because of Forest Service funding, we now have an unprecedented data set that will set the standard for community ecology research on snakes. In addition, the data will form the basis of Kevin Baker's dissertation work, meaning that Forest Service funding will have supported two graduate degrees.

Effects of Fire on Lizards at the Cascabel Ranch Watersheds

Once again, the plan was to finally conduct a warm-season burn of the watersheds at Cascabel Ranch. Unfortunately, the Forest Service was unable to burn, so we obtained another year of baseline data on lizards. Although we are eager to conduct post-burn sampling, the ability to obtain four years (2004-2007) of baseline data will provide us with a much better picture of natural variation in lizard numbers, allowing for a more thorough analysis of potential effects of fire. In 2007, we once again spent 48 person-days at Cascabel Ranch, during which time we observed a total of 595 lizards. We have now observed over 6,000 lizards since beginning in 2004. Although the Forest Service hoped to conduct a cool-season burn in late 2007/early 2008, they were unable to do so. We are hopeful that they will finally be able to burn this year, so we can begin to obtain post-burn data.

Ridge-nosed Rattlesnake Research in Mexico

In 2007, we were finally able to obtain a Mexican scientific research permit, and resume work in the Sierra San Luis. We made two week-long trips to Rancho Pan Duro in the Cajon Bonito. The site was worked by Kirk Setser from 2003-2004 (funded by a separate Forest Service agreement), but we were unable to continue in 2005-2006. Although we were only able to make two visits to one of three sites where we will eventually work, we still captured 36 ridge-nosed rattlesnakes. The important thing about this research is the ability to conduct a comprehensive, range-wide study on ridge-nosed rattlesnake habitat selection. We have now collected detailed habitat data on multiple spatial scales for 36 individual snakes at Rancho Pan Duro. Next year, we will obtain habitat data on all ridge-nosed rattlesnakes captured at two additional sites in the Sierra San Luis, and at sites in the Animas and Peloncillo Mountains. A comprehensive study of habitat selection will enable us to determine aspects of snake habitat that are shared in common among mountain ranges, and provide useful information on habitat use before and after fires differing in age. The overall goal is to apply what we learn to better inform management of ridge-nosed rattlesnakes in the Peloncillo Mountains where they are extremely rare and where the need to reintroduce fire is at the heart of maintaining a healthy forest as described in the fire management plan.